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NATIONAL DAM SAFETY PROGRAM. GRACE MINE TRAILINGS DAM, (NDI-PA0--ETC(U)  
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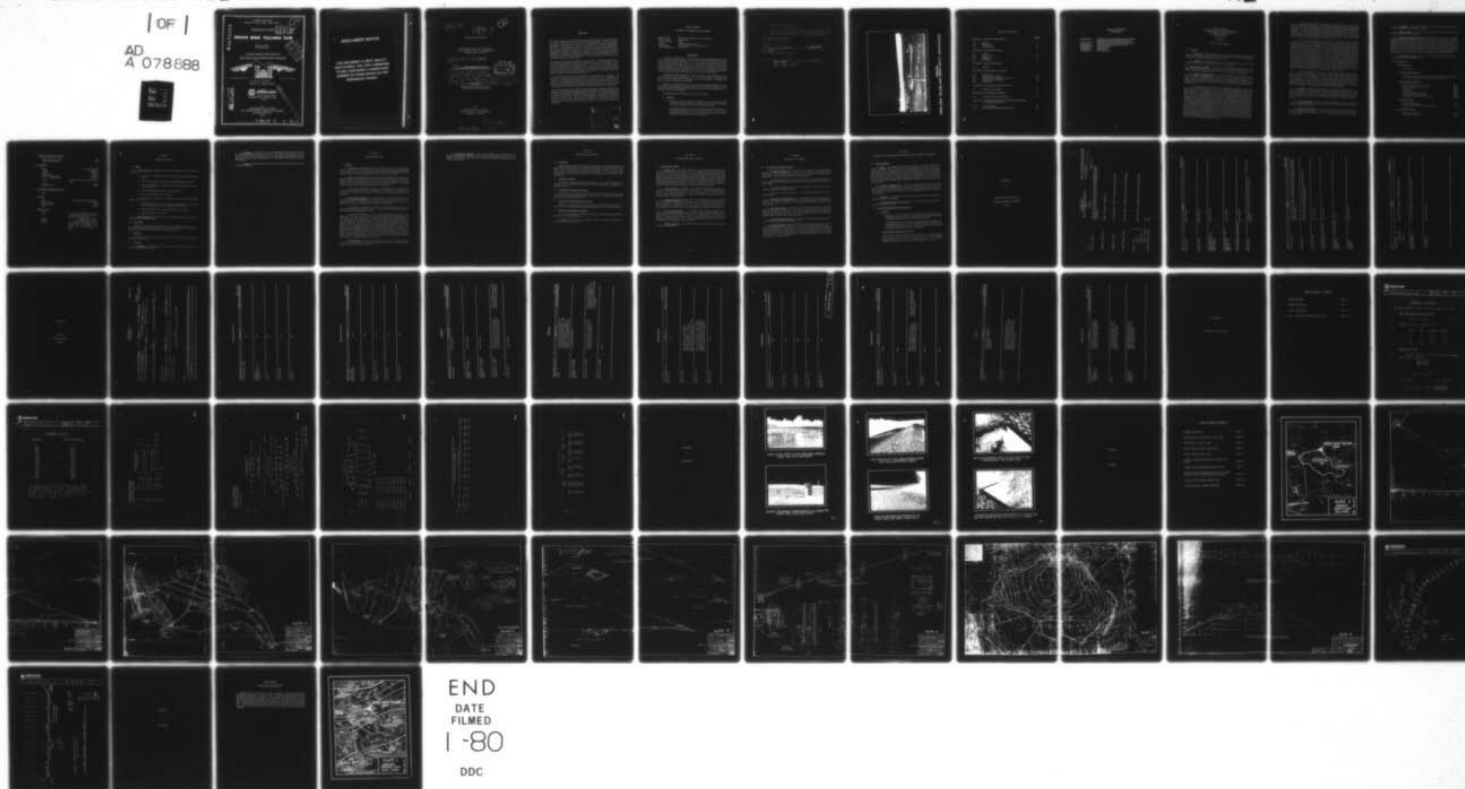
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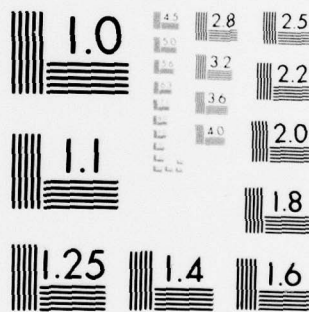
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DELAWARE RIVER BASIN  
TRIBUTARY TO HAY CREEK, BERKS COUNTY

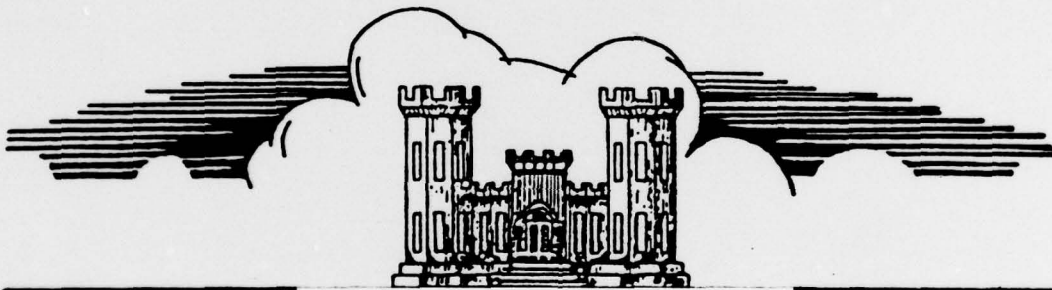
PENNSYLVANIA

LEVEL II

# GRACE MINE TAILINGS DAM

NDI-PA 00715  
PA DER 6-445

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM



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Prepared By

**O'BRIEN & GERE**

Justin & Courtney Division  
PHILADELPHIA, PENNSYLVANIA  
19103

FOR

DEPARTMENT OF THE ARMY  
BALTIMORE DISTRICT CORPS OF ENGINEERS  
BALTIMORE, MARYLAND  
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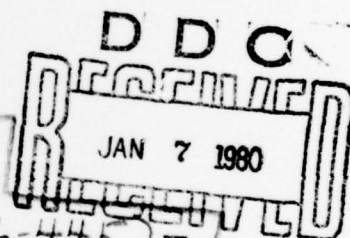
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DELAWARE RIVER BASIN

Name of Dam: Grace Mine Tailings Dam  
County and State: Berks County, Pennsylvania  
Inventory Number: PA 00715

(15) DACW31-79-C-0010

(6) PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM.  
Grace Mine Tailings Dam,  
(NDI-PA 00715, PA DER 6-445)  
Delaware River Basin, Tributary  
to Hay Creek, Berks County,  
Pennsylvania. Phase I Inspection Report.



Prepared by:  
O'BRIEN & GERE ENGINEERS, INC.  
JUSTIN & COURTNEY DIVISION

For:  
DEPARTMENT OF THE ARMY  
Baltimore District, Corps of Engineers  
Baltimore, MD 21203

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## PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I REPORT  
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Grace Mine Tailings Dam - ID # PA 00715  
State Located: Pennsylvania  
County Located: Berks  
Stream: Tributary to Hay Creek  
Coordinates: Latitude 40° 11.3' Longitude 75° 52.1'  
Date of Inspection: May 15, 1979

ASSESSMENT

Grace Mine Tailings Dam is an earth and rockfill embankment with a clay-lined, rock-filled spillway channel and five reinforced concrete decants which feed into a 20-inch diameter outlet pipe. The decants function as drop inlet spillways when the outlet gate is open. The dam is approximately 2,000 feet long with a maximum height of 145 feet and impounds a reservoir with a normal pool storage capacity of 525 acre-feet. The purpose of the reservoir is for storage of the tailings from the Bethlehem Mines Corporation iron mine. The dam is located on a tributary of Hay Creek, approximately 3 miles northwest of Elverson, Pennsylvania.

The Spillway Design Flood (SDF) for this "Large" size, "High" hazard structure is the Probable Maximum Flood (PMF). The reservoir is capable of containing the full PMF in storage without overtopping of the embankment. Therefore, the spillway system is classified as "Adequate".

Based on visual observations and review of the information obtained from the Pennsylvania Department of Environmental Resources (DER), Division of Dam Safety and from the Bethlehem Mines Corporation, Grace Mine Tailings Dam is considered to be in good condition.

Recommendations and remedial measures are as follows:

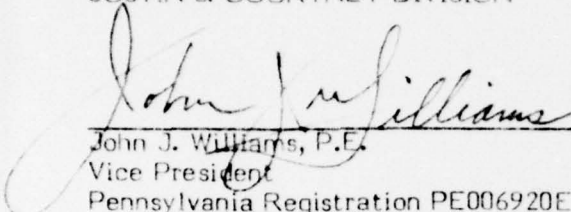
a. Facilities

1. The top of the dam should be restored to design elevation with suitable compacted material. Surface monuments should be installed to monitor any future settlement of the top of the dam.
2. The seepage observed at the left abutment should be monitored. If any substantial increases in flow or migration of fines are noted, then a drainage pipe should be provided for this seepage to insure that the integrity of the embankment is not endangered.

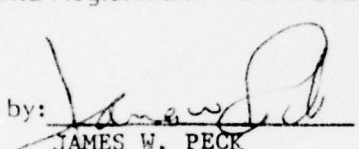
b. Operation and Maintenance Procedures

A downstream warning system should be developed. During periods of heavy rainfall, the dam should be monitored and downstream residents should be alerted in the event of an impending failure. The inoperable Parshall flumes should be repaired to aid in monitoring discharges.

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JUSTIN & COURTNEY DIVISION

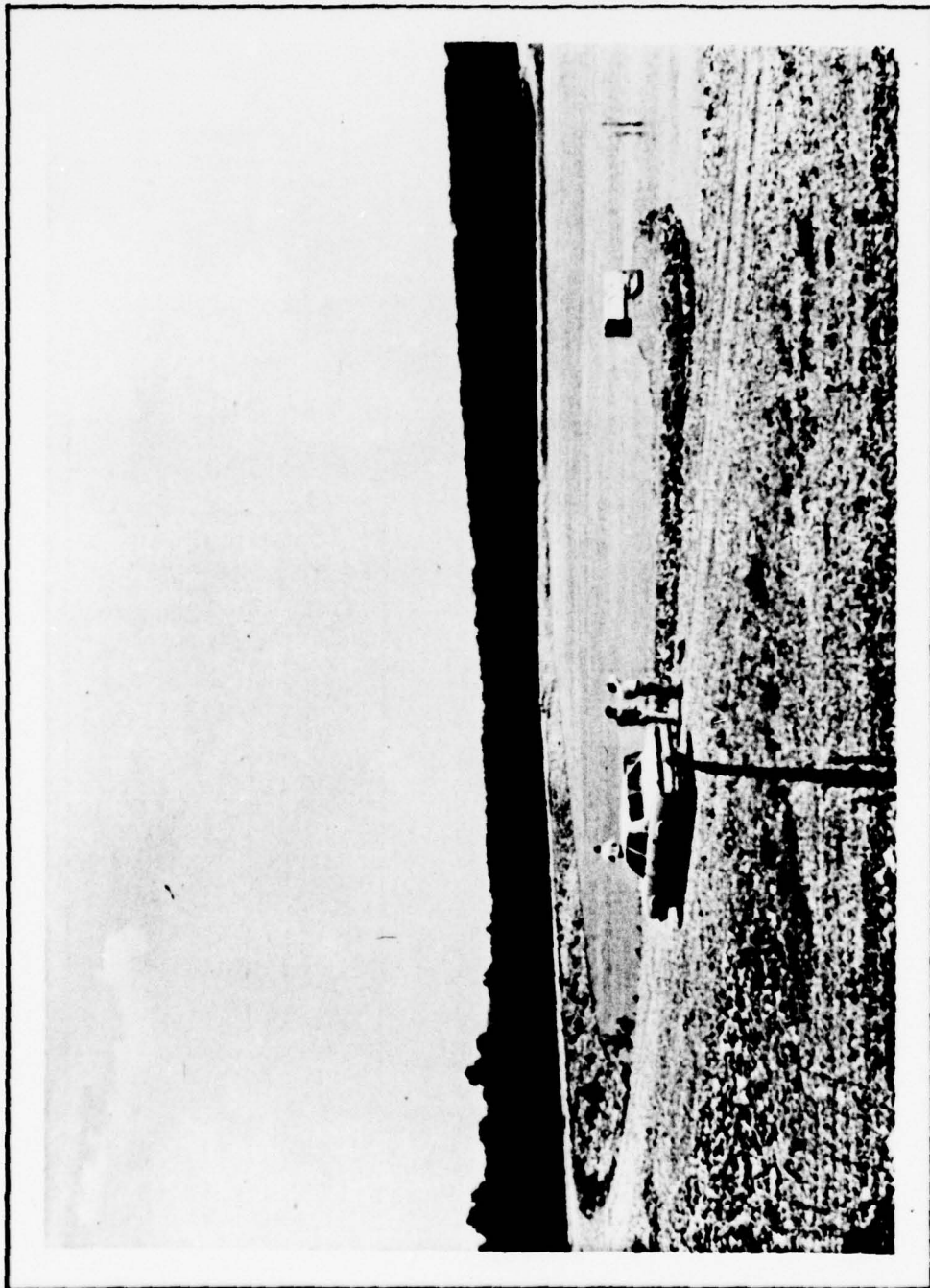
  
John J. Williams, P.E.  
Vice President  
Pennsylvania Registration PE006920E

Date: 5 Sept. 1979

Approved by:   
JAMES W. PECK  
Colonel, Corps of Engineers  
District Engineer

Date: 19 Sep 1979





*OVERVIEW  
GRACE MINE TAILINGS DAM, BERKS COUNTY, PENNSYLVANIA*

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PHASE I REPORT  
NATIONAL DAM INSPECTION PROGRAM  
GRACE MINE TAILINGS DAM  
NDI I.D. NO. 00715  
DER # 6-445

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of this inspection is to determine if the Grace Mine Tailings Dam constitutes a hazard to human life or property.

1.2 Description of Project (Based upon information obtained from the Pennsylvania Department of Environmental Resources (DER), Division of Dam Safety, Harrisburg, Pennsylvania, and from the Bethlehem Mines Corporation.)

*Abstract*  
a. Dam and Appurtenances. Grace Mine Tailings Dam is an earth and rockfill embankment approximately 2,000 feet long with a maximum height of 145 feet. The dam was constructed to impound iron ore tailings slurry pumped from a nearby iron mine operated by the Bethlehem Mines Corporation. The reservoir area provides storage space for the tailings which settle out of the slurry to leave a clear water lake.

A homogeneous, impervious earth embankment was originally constructed in 1956-1957 to Elevation 600. Two extension dikes were constructed to Elevation 620 in 1976-1977. These dikes are located several hundred feet to the south of the right abutment. The side slopes were 3 horizontal to 1 vertical (3H:1V) from the base of the dam to Elevation 540 and 2.5H:1V from Elevation 540 to the top of the dam. In the late 1960's, the dam was raised to Elevation 615 by extending the upstream face on a 2.5H:1V slope and steepening the downstream slope to 1.75H:1V. The portion of the embankment above Elevation 600 is composed of rockfill with a 5-foot thick clay layer near the upstream face which extends to the top of the dam. A filter layer provides transition between the rockfill and the clay layer on each side. The Bethlehem Mines Corporation had originally intended to raise the dam to Elevation 631. The downstream slope was to be reconstructed in two stages, from the base of the dam to Elevation 540 and from Elevation 540 to the top of the dam. The lower portion was completed leaving a large berm at Elevation 540 upon which the upper portion was to be constructed. However, the mine was closed in July, 1977 and construction of the dam was stopped with the top at Elevation 615.0 and the berm at Elevation 540.0 about 80 feet wide.

*Abstract*

The spillway for the dam is located near the left abutment. It is a 50-foot wide rock-filled, clay-lined channel. The spillway channel is formed by impervious clay boundaries and is filled with rock so that the spillway has minimal discharge capacity. The upstream clay layer terminates at Elevation 611.0 to form the spillway crest. The spillway channel through the dam is lined on the invert by a 5-foot thick clay layer which drops from Elevation 608 to 606.6 and by 12-foot thick clay layers on each side (see Plate 8 in Appendix E). The clay layers are protected on both sides of the spillway by 12-foot thick filter zones.

The outlet works consist of a series of reinforced concrete decants connected by a 20-inch diameter steel pipe which leads into another 20-inch diameter steel pipe located beneath the embankment with a 20-inch gate valve at the outlet end (see Plate 3, Appendix E). Each decant is 25 feet high, has three walls, and contains a bell inlet 10 feet above the base of the structure. Inflow stages are controlled by means of stop logs above the bell inlet elevation, which is also the crest elevation of the decant. Five decants are located near the upstream toe stretching from the main inlet structure to the left abutment with crest elevations of 520, 550, 580, 595, and 610. Only one decant is in operation at any time and as the reservoir level rises and each decant becomes submerged, the bell inlet is replaced by a blind flange, the pipe is encased in concrete and the bell inlet is transferred to the next higher decant. The water level has been near the top of the fourth decant since mining operations ceased in 1977. A 20-inch diameter steel pipe directs flow from the operating decant to the main inlet structure. The flow then discharges through another 20-inch diameter steel pipe beneath the embankment into the outlet structure, which leads into the natural stream.

A drainage system consisting of a trench drain, blanket drain and toe drain, underlies the embankment. The trench drain is 50 feet wide, has a 10-foot base width, and 10-foot depth, and extends from Station 1+50 to Station 8+00 (Station 0+00 is at the left abutment). The toe drain extends the entire length of the embankment and is connected to the trench drain by means of a 5-foot thick blanket drain between Stations 3+50 and 8+00. The blanket drain extends about one hundred feet further than the trench drain toward the right abutment. All three drains are composed of rock with one-foot thick filters on all sides.

b. Location. Grace Mine Tailings Dam is located on a tributary to Hay Creek approximately 3 miles northwest of the town of Elverson, Pennsylvania. The dam lies within Caernarvon Township in Berks County and is shown on the USGS Quadrangle entitled, "Elverson, Pennsylvania" at coordinates N 40° 11.3', W 75° 52.1'. A regional location plan of Grace Mine Tailings Dam is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam has a maximum height of about 145 feet and a maximum storage capacity of approximately 1,650 acre-feet. Therefore, the dam is in the "Large" size category.

d. Hazard Classification. A number of inhabitable structures are located in the valley downstream of the dam. Failure of the dam would result in excessive property damage and probable loss of life. Therefore, the dam is in the "High" hazard category.

e. Ownership. Grace Mine Tailings Dam is owned by Bethlehem Mines Corporation, Bethlehem, Pennsylvania, 18016.

f. Purpose of Dam. The dam was constructed to impound the tailings slurry from the Bethlehem Mines iron mine.

g. Design and Construction History. According to Mr. Charles E. Taylor, Assistant Manager of Mining Operations, Grace Mine Tailings Dam was designed by D'Appolonia Consulting Engineers in 1956. The dam was constructed by Jack and Jim Mazer in 1956-1957 to Elevation 600 (original design top of dam elevation). The tailings from the iron mine were pumped into the reservoir by means of a slurry and gradually reduced the available storage in the reservoir. Considerations for raising the dam to Elevations 631 and eventually 650 were made, and in the late 1960's the initial raising was undertaken. However, in July, 1977, mining operations were closed down and construction was halted with the top of dam at Elevation 615.

h. Operating Procedures. There are no operating procedures for this dam, according to the Owner's representative.

### 1.3 Pertinent Data.

a. Drainage Area.

|              |     |
|--------------|-----|
| Square Miles | 0.7 |
|--------------|-----|

b. Discharge at Dam Site. (cfs)

There are no available records of discharge rate for the original dam and the current spillway has minimal discharge capacity.

c. Elevation. (feet above MSL)

|                                    |       |
|------------------------------------|-------|
| Reservoir Surface (as of 8-24-77)  | 607.3 |
| Reservoir Surface (as of 5-15-79)  | 608.3 |
| Spillway Crest                     | 611.0 |
| Top of Dam                         | 615.0 |
| Reservoir Drain Invert (inlet)     | 485.0 |
| Reservoir Drain Invert (outlet)    | 470.0 |
| Streambed at Downstream Toe of dam | 470.0 |

d. Reservoir. (miles)

|  |      |
|--|------|
| Length of Normal Pool                  | 0.42 |
| Length of Maximum Non-overtopping pool | 0.43 |

c. Storage. (acre-feet)

|                          |       |
|--------------------------|-------|
| Normal Pool, Elev. 608.3 | 525   |
| Top of Dam, Elev. 615    | 1,650 |



f. Reservoir Surface Area. (acres)

|                          |     |
|--------------------------|-----|
| Normal pool, Elev. 608.3 | 132 |
| Top of Dam, Elev. 615    | 198 |

g. Dam Data.

|                        |   |
|------------------------|---|
| Type                   | Earth and rockfill                      |
| Length                 | 2,000 feet                              |
| Height                 | 145 feet                                |
| Crest Width            | 30 feet                                 |
| Side Slopes (upstream) | 2.5H:1V                                 |
| (downstream)           | 1.75H:1V                                |
| Zoning                 | Above Elev. 600, refer to Section 1.2.a |
| Cutoff                 | None                                    |
| Grout Curtain          | None                                    |

h. Diversion and Regulating Tunnel.

None

i. Spillway.

|                 |                                 |
|-----------------|---------------------------------|
| Type            | Rock-filled, clay-lined channel |
| Crest Length    | 50 feet                         |
| Crest Elevation | 611.0                           |
| Gates           | None                            |

j. Outlet Works.

Type

A series of reinforced concrete decants which feed into a 20-inch diameter steel outlet pipe

Length  
Closure  
Access

Outlet pipe - 730 feet  
Gate at the downstream toe  
The valve that controls the downstream gate is accessible. The decants are only accessible by boat.

## SECTION 2

### ENGINEERING DATA

#### 2.1 Design

a. Data Available. The engineering data made available by DER includes the following:

1. A set of 31 design drawings for the original embankment (dated 1956).
2. A set of 10 design drawings for the extension dikes (dated 1970).
3. "General Plan Map for Expanding Existing Tailings Dam & Pond - Crest Elev. 650".
4. "Specifications for Tailings Dam to Elevation 620".
5. Several Miscellaneous Regional Maps.

Three additional drawings were obtained from the Bethlehem Mines Corporation. They are:

1. The proposed plan for the Tailings Dam Expansion to crest Elev. 631 with approximate conditions as of August 24, 1977 shown.
2. "Idealized Sections Thru Tailings Dam Spillway - 615 Crest".
3. Details of the #5 & #6 decants.

b. Design Features. The design features are described in Section 1.2.a and shown on the Plates in Appendix E.

#### 2.2 Construction

Construction reports and photographs were not obtained from DER. Construction information and dates supplied in this report were provided by Mr. Fred Eben, Project Engineer for the Bethlehem Mines Corporation.

#### 2.3 Operation

According to the Owner's representative, there are no known operating records maintained for this dam.

#### 2.4 Evaluation

a. Availability. All information made available was obtained from DER and the Bethlehem Mines Corporation.



b. Adequacy. No design reports or correspondence was provided by DER or the Bethlehem Mines Corporation. However, the information (listed in Section 2.1.a) provided by DER and Bethlehem Mines Corporation, visual observations, and discussions with the Owner's representative are considered adequate for a Phase I investigation.

c. Validity. There appears to be no reason to question the validity of the available information.

## SECTION 3

### VISUAL INSPECTION

#### 3.1 Findings

a. General. The field inspection of Grace Mine Tailings Dam took place on May 15, 1979. At the time of the inspection, the water surface was approximately 1.7 feet below the crest of decant #5 and approximately 2.7 feet below the spillway crest, Elevation 611.0. No underwater areas of the dam were inspected.

b. Dam. The downstream slope of the embankment appears to be consistent with the design drawing slope of 1.75H:1V. The slope is composed of rockfill, has an 80-foot wide berm at elevation 540 and appears to be in good condition. The visible portion of the upstream slope also appears to be in good condition. The rockfill material on the surface of the dam appears to be well graded.

The survey of the crest of the dam revealed variations in elevation of more than a foot (refer to Plate 10, Appendix E). A depressed area located in the vicinity of the outlet pipe centerline was surveyed as nearly a foot below design elevation.

c. Appurtenant Structures. The spillway section is a rock filled channel that is difficult to differentiate from the remainder of the structure on the basis of surface appearance. The condition of the spillway crest and side walls could not be determined. There is no outlet channel provided for the spillway.

The spillway is designed to release any reservoir surcharge through a controlled process by permitting the water to discharge slowly through interstices of the rock used to fill the spillway opening.

The first three decants were completely submerged on the date of the inspection. The water level was near the top of decant #4 and approximately 1.7 feet below the crest of decant #5. Both decants appeared to be in good condition. The connecting pipe extends beyond decant #5 and above the water surface to natural ground on the left abutment. The outlet pipe was discharging a small amount of flow (0.1 cfs) into the outlet structure during the inspection. The outlet structure is a rectangular concrete box, approximately 10 feet by 12 feet, which releases the flow through a Parshall flume and into the downstream channel. An additional Parshall flume is located in the channel downstream, but it is in a state of disrepair. Some discharge (0.15 cfs) was observed from the outlet end of a 12-inch diameter spring drain pipe which protrudes from the right abutment approximately 70 feet from the outlet structure. Water was also observed flowing down the left abutment slope and into the downstream channel.

d. Reservoir Area. The average reservoir side slopes are about 10 percent and are well vegetated. The extension dikes form the reservoir boundary along a portion of the reservoir south of the dam.

e. Downstream Channel. The natural channel slopes downward on an approximate grade of 1.5 percent for about one mile downstream, where it joins Hay Creek. Approximately five inhabitable structures are located along this one mile stretch of the stream.

## SECTION 4

### OPERATIONAL FEATURES

#### 4.1 Procedures

Operational procedures prior to shutdown of the mine consisted of placing stop logs in the operating decant and operating the downstream control valve for the outlet works. According to the Owner's representative, the gate has been in the open position since the reservoir surface overtopped the third decant crest. However, since tailings inflow ceased in 1977, there have been no formal operating procedures.

#### 4.2 Maintenance of Dam

According to the Owner's representative, the dam is inspected regularly by employees of the Bethlehem Mines Corporation and maintenance is performed as deemed necessary.

#### 4.3 Maintenance of Operating Facilities

According to the Owner's representative, the only operating facility that would require maintenance is the downstream gate valve. This valve has not been maintained or operated in recent years.

#### 4.4 Description of Warning Systems in Effect

There is no evidence that any warning system is in effect for this site. A Parshall flume for measuring flow in the downstream channel is no longer operable.

#### 4.5 Evaluation of Operational Adequacy

A formal warning system should be developed to alert downstream residents in the event of an impending failure.

It appears that the dam is accessible under all weather conditions for inspection and emergency action.



## SECTION 5

### HYDRAULICS AND HYDROLOGY

#### 5.1 Evaluation of Features

a. Design Data. Grace Mine Tailings Dam has a drainage area of 0.7 square miles and impounds a reservoir with a normal pool (Elev. 608.3) storage capacity of 525 acre-feet of water (in addition to the accumulated tailings storage). The spillway is a 50-foot wide clay-lined and rock-filled channel which has a minimal discharge capacity and controls high pool stages by allowing the water to discharge slowly through interstices of the rock used to fill the spillway opening. Reservoir stages below the spillway crest are controlled by the operating decant which acts as a drop inlet spillway when the gate is in the open position. The crest elevation is determined by the number of stop logs in place in the operating decant.

b. Experience Data. According to the Owner's representative, there are no rainfall or reservoir level records kept for this dam. Three Parshall flumes are available for measuring flow; one for the outlet pipe, one in the right (south) abutment, and one in the downstream channel. However, no consistent records were ever maintained for these flumes.

c. Visual Observations. On the date of the inspection, the reservoir surface was approximately 2.7 feet below the spillway crest. A small amount of water (0.1 cfs) was flowing over the stop log crest of decant #4 and discharging from the outlet pipe downstream. Decant #4 was functioning as a drop inlet spillway and maintaining the reservoir surface at Elevation 608.3 on the date of the inspection.

d. Overtopping Potential. The hydraulic and hydrologic analyses were performed under the assumptions that the outlet gate is closed and the rockfill spillway has no discharge capacity. Therefore, it was assumed that the dam is not capable of discharging any of the inflow. Using these analyses, the reservoir is capable of storing the entire PMF without overtopping of the low point of the embankment (see Appendix C for computations).

e. Spillway Adequacy. The spillway system for Grace Mine Tailings Dam is classified as "Adequate".

## SECTION 6

### STRUCTURAL STABILITY

#### 6.1 Evaluation of Structural Stability

a. Visual Observations. The variations in elevation of the crest of the dam could be a result of differential settlement due to poor compaction during construction. The additional weight of the 15 feet of rockfill used for raising the embankment could also have contributed to the settlement.

The seepage observed from the left abutment was of similar quantity to the discharge from the right abutment spring drain and could also be the result of spring water.

The visible portions of decants #4 and #5 appear to be in good condition and show no signs of structural instability.

Based on the visual observations, the embankment appears to be structurally stable.

b. Design and Construction Data. A complete set of design drawings was obtained from DER. However, there were no design calculations or construction reports made available. A list of the engineering data available from DER is given in Section 2.1.a.

c. Operating Records. According to the Owner's representative, the outlet gate has been open since the water level reached decant #3. No records were ever kept for the operation of the gate. Parshall flumes are available for measuring the flow through the outlet pipe, from the right abutment, and in the downstream channel. These flumes are in a state of disrepair.

d. Post Construction Changes. In the late 1960's the original embankment was raised from Elevation 600 to Elevation 615.

e. Seismic Stability. Grace Mine Tailings Dam is located in Seismic Zone 1 on the Seismic Zone Map of Contiguous States. A dam located in Seismic Zone 1 is generally considered to be safe under any expected earthquake loading conditions if it is safe under static loading conditions. However, it should be noted that three minor tremors have been recorded since 1954 which originated within twenty miles of the dam site. These tremors have been classified according to the Modified Mercalli Scale as intensity V or VI.



## SECTION 7

### ASSESSMENT, RECOMMENDATIONS, & PROPOSED REMEDIAL MEASURES

#### 7.1 Dam Assessment

a. Safety. The visual observations and review of available information indicate that Grace Mine Tailings Dam is in good condition. The survey of the crest of the dam revealed that an area near the longitudinal center of the embankment has settled nearly a foot below design elevation. However, the reservoir is capable of containing the Probable Maximum Flood with no discharge and without the low point on the crest of the dam being overtopped. Seepage from the left abutment near the outlet structure was observed during the inspection. The exact source of the seepage could not be determined although a natural spring seems to be the most probable cause.

b. Adequacy of Information. There were no design calculations or construction reports made available by DER. However, the information (listed in Section 2.1.a) provided by DER and Bethlehem Mines Corporation, visual observations and discussions with the Owner's representative are considered adequate for a Phase I investigation.

c. Urgency. The remedial measures recommended in Section 7.2 should be implemented as soon as possible.

d. Necessity for Further Investigation. No further investigations are considered necessary at this time.

#### 7.2 Recommendations and Remedial Measures

##### a. Facilities

1. The top of the dam should be restored to design elevation with suitable compacted material. Surface monuments should be installed to monitor any future settlement of the top of the dam.
2. The seepage observed at the left abutment should be monitored. If any substantial increases in flow or migration of fines are noted, then a drainage pipe should be provided for this seepage to insure that the integrity of the embankment is not endangered.

##### b. Operation and Maintenance Procedures

A downstream warning system should be developed. During periods of heavy rainfall, the dam should be monitored and downstream residents should be alerted in the event of an impending failure. The inoperable Parshall flumes should be repaired to aid in monitoring discharges.

APPENDIX

A

Check List Engineering Data  
Design, Construction, Operation  
Phase I

CHECK LIST  
ENGINEERING DATA  
DESIGN, CONSTRUCTION, OPERATION  
PHASE I

NAME OF DAM Grace Mine Tailing Dam  
ID # PA 00715

Sheet 1 of 4

ITEM

REMARKS

AS-BUILT DRAWINGS

An "As-Built" plan drawing for the raised embankment showing existing conditions was obtained from the Bethlehem Mines Corporation.

REGIONAL VICINITY MAP

Refer to Plate 1, Appendix E.

CONSTRUCTION HISTORY

No construction reports were made available by DER.

TYPICAL SECTIONS OF DAM

See the Plates in Appendix E for available drawings.

OUTLETS - PLAN

DETAILS

CONSTRAINTS

DISCHARGE RATINGS

RAINFALL/RESERVOIR RECORDS

See the Plates in Appendix E for available drawings.

None

None

| ITEM  | REMARKS   |
|---|---|
| DESIGN REPORTS  | None available.   |
| GEOLOGY REPORTS   | None available.   |
| DESIGN COMPUTATIONS<br>HYDROLOGY & HYDRAULICS<br>DAM STABILITY<br>SEEPAGE STUDIES | None available.   |
| MATERIALS INVESTIGATIONS<br>BORING RECORDS<br>LABORATORY }<br>FIELD }             | None available.   |
| POST-CONSTRUCTION SURVEYS OF DAM  | None available.   |
| BORROW SOURCES  | A location map showing borrow area was obtained from DER. |

| ITEM  | REMARKS  |
|---|--|
| MONITORING SYSTEMS                                    | Several Parshall flumes for measuring flow are located immediately downstream of the dam. No records have been maintained for these flumes, however. |
| MODIFICATIONS   | Several drawings were obtained from the Bethlehem Mines Corporation for the raised embankment.   |
| HIGH POOL RECORDS                                     | None available.  |
| POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS     | None available.  |
| PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS | None   |
| MAINTENANCE OPERATION RECORDS                         | None available.  |



| ITEM  | REMARKS  |
|---|--|
| <div> <div>SPILLWAY PLAN</div> <div> <div>SECTIONS</div> <div>DETAILS</div> </div> </div> | See Plates in Appendix E for available drawings. |
| OPERATING EQUIPMENT<br>PLANS & DETAILS  | See Plates in Appendix E for available drawings. |
| MISCELLANEOUS   | Refer to Section 2.1.a                           |



APPENDIX

B

Check List

Visual Inspection

Phase I

Sheet 1 of 11

# National!

M.S.L.

J. J. Williams

Robert R. Bowers

Recorder

Mr. Fred Eben, Project Engineer for Bethlehem Mines Corporation, was present during the  
Inspection.

# CONCRETE/MASONRY DAMS

Sheet 2 of 11

| VISUAL EXAMINATION OF                            | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|--|--------------|----------------------------|
| ANY NOTICEABLE SEEPAGE                           | N/A          |                            |
| STRUCTURE TO<br>ABUTMENT/EMBANKMENT<br>JUNCTIONS | N/A          |                            |
| DRAINS   | N/A          |                            |
| WATER PASSAGES                                   | N/A          |                            |
| FOUNDATION                                       | N/A          |                            |

# CONCRETE/MASONRY DAMS

Sheet 3 of 11

| VISUAL EXAMINATION OF                | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|--------------------------------------|--------------|----------------------------|
| SURFACE CRACKS<br>CONCRETE SURFACES  | N/A          |                            |
| STRUCTURAL CRACKING                  | N/A          |                            |
| VERTICAL AND HORIZONTAL<br>ALIGNMENT | N/A          |                            |
| MONOLITH JOINTS                      | N/A          |                            |
| CONSTRUCTION JOINTS                  | N/A          |                            |



EMBANKMENT

Sheet 4 of 11

| <u>VISUAL EXAMINATION OF</u>                                 | <u>OBSERVATIONS</u>   | <u>REMARKS OR RECOMMENDATIONS</u>  |
|--|---|--|
| SURFACE CRACKS   | None observed   |  |
| UNUSUAL MOVEMENT OR<br>CRACKING AT OR BEYOND<br>THE TOE      | None observed   |  |
| SLOUGHING OR EROSION OF<br>EMBANKMENT AND ABUTMENT<br>SLOPES | None observed   |  |
| VERTICAL AND HORIZONTAL<br>ALIGNMENT OF THE CREST            | The survey of the crest of the<br>dam revealed vertical variations<br>of greater than a foot, possibly<br>due to differential settlement. | Surface monuments should be<br>placed along the crest to<br>monitor future settlement. |
| RIPRAP FAILURES  | None observed   |  |

EMBANKMENT

Sheet 5 of 11

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|-----------------------|--------------|----------------------------|
|-----------------------|--------------|----------------------------|

DRAINS

The spring drain pipe appeared to be functioning properly. The trench drain, blanket drain, and toe drain system is located at the base of the embankment and could not be properly evaluated.

JUNCTION OF EMBANKMENT  
AND ABUTMENT, SPILLWAY  
AND DAM

No problems observed.

ANY NOTICEABLE SEEPAGE

Water was seeping from the left abutment near the outlet structure during the inspection.

Further investigation is recommended to determine the source of the seepage. A drain pipe should be provided if necessary.

STAFF GAGE AND RECORDER

None

UNGATED SPILLWAY

Sheet 7 of 11

| <u>VISUAL EXAMINATION OF</u> | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|------------------------------|---------------------|-----------------------------------|
|------------------------------|---------------------|-----------------------------------|

|               |  |  |
|---------------|--|--|
| CONCRETE WEIR |  |  |
|---------------|--|--|

N/A

|                  |  |  |
|------------------|--|--|
| APPROACH CHANNEL |  |  |
|------------------|--|--|

The spillway is a clay-lined rock-filled channel with no discharge capacity. This section would function as a seepway rather than a spillway. There is no actual approach channel.

|                   |  |  |
|-------------------|--|--|
| DISCHARGE CHANNEL |  |  |
|-------------------|--|--|

The crest of the spillway section is at Elevation 611. The channel through the embankment drops from Elevation 608 to Elevation 606.6. Refer to the Plates in Appendix E.

|                  |  |  |
|------------------|--|--|
| BRIDGE AND PIERS |  |  |
|------------------|--|--|

N/A

GATED SPILLWAY

Sheet 8 of 11

| VISUAL EXAMINATION OF            | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|----------------------------------|--------------|----------------------------|
| CONCRETE SILL                    | N/A          |                            |
| APPROACH CHANNEL                 | N/A          |                            |
| DISCHARGE CHANNEL                | N/A          |                            |
| BRIDGE AND PIERS                 | N/A          |                            |
| GATES AND OPERATION<br>EQUIPMENT | N/A          |                            |

PRECEDING PAGE BLANK



INSTRUMENTATION

Sheet 9 of 11

| <u>VISUAL EXAMINATION</u> | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|---------------------------|---------------------|-----------------------------------|
|---------------------------|---------------------|-----------------------------------|

|                       |      |  |
|-----------------------|------|--|
| MONUMENTATION/SURVEYS | None |  |
|-----------------------|------|--|

|                   |      |  |
|-------------------|------|--|
| OBSERVATION WELLS | None |  |
|-------------------|------|--|

|       |   |   |
|-------|---|---|
| WEIRS | Several Parshall flumes are located immediately downstream of the embankment for measuring the flow at various locations. | Repair any inoperable flumes if helpful in developing a warning system. |
|-------|---|---|

|             |      |  |
|-------------|------|--|
| PIEZOMETERS | None |  |
|-------------|------|--|

|       |      |  |
|-------|------|--|
| OTHER | None |  |
|-------|------|--|

RESERVOIR

Sheet 10 of 11

| <u>VISUAL EXAMINATION OF</u> | <u>OBSERVATIONS</u> | <u>REMARKS OR RECOMMENDATIONS</u> |
|------------------------------|---------------------|-----------------------------------|
|------------------------------|---------------------|-----------------------------------|

SLOPES

The reservoir slopes are fairly steep and well vegetated.

SEDIMENTATION

The accumulated tailings have significantly reduced the storage capacity of the reservoir. The dam was raised to Elevation 615 to create more storage to accommodate more tailings.

DOWNSTREAM CHANNEL

Sheet 11 of 11

| VISUAL EXAMINATION OF                         | OBSERVATIONS  | REMARKS OR RECOMMENDATIONS |
|---|---|----------------------------|
| CONDITION<br>(OBSTRUCTIONS,<br>DEBRIS, ETC.)  | There were no visible obstructions of the downstream channel on the date of the inspection.                       |                            |
| SLOPES  | The downstream channel slopes on an approximate grade of 1.5 percent for about one mile where it joins Hay Creek. |                            |
| APPROXIMATE NO.<br>OF HOMES AND<br>POPULATION | Approximately 5 homes and 25 people are located in the area which would be flooded in the event of a dam failure. |                            |

APPENDIX

C

Hydrologic & Hydraulic Data



TABLE OF CONTENTS - APPENDIX C

|  |            |
|--|------------|
| PMP CALCULATIONS                           | SHEET 1    |
| SNYDER COEFFICIENTS                        | SHEET 1    |
| STAGE - AREA VALUES                        | SHEET 2    |
| HEC - 1 DAM SAFETY VERSION COMPUTER OUTPUT | SHEETS 3-7 |



O'BRIEN & GERE

SUBJECT

GRACE MINE TAILINGS DAM

SHEET

1

BY

RRB

DATE

6/77

JOB NO

### HYDROLOGY CALCULATIONS

DRAINAGE AREA (PLANIMETERED ON USGS QUAD SHEET): 0.7 SQ. MI.

### PMP CALCULATIONS (HM REPEAT 33)

AREA IS IN ZONE 6

24 HR., 200 SQ. MI. RAINFALL = 23 "

| <u>HR.</u> | <u>%</u> | <u>RAINFALL</u> | <u>Δ RF</u> |
|------------|----------|-----------------|-------------|
| 6          | 113      | 26.0 "          | 26.0 "      |
| 12         | 123      | 28.3 "          | 2.3 "       |
| 24         | 132      | 30.4 "          | 2.1 "       |
| 48         | 142      | 32.7 "          | 2.3 "       |

### SNYDER COEFFICIENTS

FROM INFO. PROVIDED BY THE COE FOR THE SUSQUEHANNA RIVER BASIN, ZONE 15 C :

$$C_p = 0.82$$

AND

$$C_t = 2.78$$

$$t_p = C_t (L \cdot L_{ca})^{0.3}$$

$$L = 1.3 \text{ MILES}$$

$$L_{ca} = 0.6 \text{ MILES}$$

$$t_p = 2.78 (1.3 \cdot 0.6)^{0.3} = 2.58 \text{ HRS.}$$



O'BRIEN & GERE

SUBJECT

Grace Mills Tailings Dam

SHEET

2

BY

ERB

DATE

6/79

JOB NO

STAGE-AREA VALUES

ELEVATION

SURFACE AREA (ACRES)

|     |       |
|-----|-------|
| 600 | 6.5   |
| 602 | 27.2  |
| 604 | 59.6  |
| 606 | 88.2  |
| 608 | 128.6 |
| 610 | 150.6 |
| 612 | 171.5 |
| 614 | 191.5 |
| 616 | 204.2 |
| 618 | 213.9 |
| 620 | 225.5 |
| 625 | 251.5 |

THE SPILLWAY HAS BEEN FILLED WITH ROCK, THEREBY REDUCING THE DISCHARGE CAPACITY TO ZERO. A SPILLWAY CREST ELEVATION OF 615.0, THE SAME ELEVATION AS THE TOP OF THE DAM, IS INPUT TO THE HEC-1 PROGRAM TO REFLECT THE NEGLIGIBLE DISCHARGE CAPACITY.

.....  
 FLOOD HYDROGRAPH PACKAGE (HEC-1)  
 DAM SAFETY VERSION JULY 1974  
 LAST MODIFICATION 25 SEP 78  
 .....

|    |     |    |   |   |   |   |   |     |   |
|----|-----|----|---|---|---|---|---|-----|---|
| 1  | A1  | 30 | 0 | 0 | 0 | 0 | 0 | -4  | 0 |
| 2  | A2  | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 3  | A3  | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 4  | A4  | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 5  | A5  | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 6  | A6  | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 7  | A7  | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 8  | A8  | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 9  | A9  | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 10 | A10 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 11 | A11 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 12 | A12 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 13 | A13 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 14 | A14 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 15 | A15 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 16 | A16 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 17 | A17 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 18 | A18 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 19 | A19 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 20 | A20 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 21 | A21 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 22 | A22 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 23 | A23 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 24 | A24 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |
| 25 | A25 | 1  | 1 | 1 | 1 | 1 | 1 | 1.0 | 1 |



\*\*\*\*\*  
 FLOOD HYDROGRAPH PACKAGE (MCC-1)  
 DAM SAFETY VERSION JULY 1978  
 LAST MODIFICATION 25 SEP 78  
 \*\*\*\*\*

QUN: DATE 05/25/79.  
 TIME 15.49.20.

NATIONAL DAM INSPECTION PROGRAM  
 GRACE MINE TAILINGS DAM  
 PMF HYDROGRAPH

| JOB SPECIFICATION |     |      |      |     |      |       |      |       |       |
|-------------------|-----|------|------|-----|------|-------|------|-------|-------|
| NO                | NHR | NMIN | IDAY | IMR | IMIN | MFTRC | IPLT | IPRT  | NSTAN |
| 150               | 0   | 30   | 0    | 0   | 0    | 0     | 0    | -4    | 0     |
| JOPER             |     |      | NMT  |     |      | LROPT |      | TRACE |       |
| 5                 |     |      | 0    |     |      | 0     |      | 0     |       |

MULTI-PLAN ANALYSES TO BE PERFORMED

NPLAN= 1 NRTIO= 9 LRTIO= 1  
 RTIO= .20 .30 .40 .50 .60 .70 .80 .90 1.00

\*\*\*\*\*

SUR-AREA RUNOFF COMPUTATION

RUNOFF TO GRACE MINE RESERVOIR

| ISTAG  | ICOMP | IFCON | ITAP | JPLT | JPR | INAME | ISTAGE | IAUTO |
|--------|-------|-------|------|------|-----|-------|--------|-------|
| INFLOW | 0     | 0     | 0    | 0    | 0   | 1     | 0      | 0     |

HYDROGRAPH DATA

| IMYOG | IUNG | TAHEA | SNAP | TSODA | TSPC | RATIO | ISNOW | ISAME | LOCAL |
|-------|------|-------|------|-------|------|-------|-------|-------|-------|
| 1     | 1    | .70   | 0.00 | .70   | 0.00 | 0.000 | 0     | 1     | 0     |

PRECIP DATA

| SPEE | PWS   | R6     | R12    | R24    | R48    | R72  | R96  |
|------|-------|--------|--------|--------|--------|------|------|
| 0.00 | 23.00 | 113.00 | 123.00 | 132.00 | 142.00 | 0.00 | 0.00 |

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

| LROPT | STKPS | DLTR | RTIO | FRAN | STKPS | RTIO | STRTL | CNSTL | ALSHX | RTIMP |
|-------|-------|------|------|------|-------|------|-------|-------|-------|-------|
| 0     | 0.00  | 0.00 | 1.00 | 0.00 | 0.00  | 1.00 | 1.00  | .05   | 0.00  | 0.00  |

UNIT HYDROGRAPH DATA  
 TP= 2.58 CP= .42 NTA= 0

RECESSION DATA  
 STRTQ= -1.50 RPSN= -.05 RTIO= 2.00

UNIT HYDROGRAPH 14 END-OF-PERIOD ORIGINATES. LAG= 2.55 HOURS. CP= .41 VOL= 1.00  
 14. 47. 118. 140. 143. 129. 60. 32.

| MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | MO.DA | HR.MN | PERIOD | RAIN | EXCS | LOSS | COMP |
|-------|-------|--------|------|------|------|-------|-------|--------|------|------|------|------|
| 0     | 0     | 0      | 0    | 0    | 0    | 0     | 0     | 0      | 0    | 0    | 0    | 0    |

SUM 26.13 23.73 2.40 22308.  
 ( 664.11 603.11 61.11 631.69)

SH 4

# HYDROGRAPH ROUTING

## ROUTING THROUGH GRACE MINE RESERVOIR

| ISTAO  | ICOMP | IECON | ITAP         | JPLT  | JPRT  | INAME | ISTAGF | IAUTO |
|--------|-------|-------|--------------|-------|-------|-------|--------|-------|
| OUTFLO | 1     | 0     | 0            | 0     | 0     | 1     | 0      | 0     |
| QLOSS  | CLOSS | AVG   | ROUTING DATA | IOPT  | IPMP  | LSTR  |        |       |
| 0.0    | 0.00  | 0.00  | 1            | 0     | 0     | 0     |        |       |
| NSTPS  | NSTDL | LAG   | AMSK         | X     | TSK   | STORA | ISPRT  |       |
| 1      | 0     | 0     | 0.000        | 0.000 | 0.000 | -608. | 0      |       |
| 7.     | 27.   | 88.   | 129.         | 151.  | 172.  | 192.  | 204.   | 214.  |
| 226.   | 252.  |       |              |       |       |       |        |       |
| 0.     | 31.   | 263.  | 478.         | 757.  | 1079. | 1442. | 1838.  | 2256. |
| 2695.  | 3497. |       |              |       |       |       |        |       |
| 600.   | 602.  | 606.  | 608.         | 610.  | 612.  | 614.  | 616.   | 618.  |
| 620.   | 625.  |       |              |       |       |       |        |       |

CEEL SPWIN COQM EXP\* FLEVL COQL CARFA FXPL  
615.0 20.0 3.1 1.5 0.0 0.0 0.0 0.0

DAM DATA  
TOPEL COQD EXPD DAMWID  
615.0 3.1 1.5 2000.

PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS  
PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS  
PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS  
PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS  
PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS  
PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS  
PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS  
PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS  
PEAK OUTFLOW IS 0. AT TIME 0.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

| OPERATION     | STATION | AREA  | PLAN | RATIOS APPLIED TO FLOWS |         |         |         |         |         |         |         |         |
|---------------|---------|-------|------|-------------------------|---------|---------|---------|---------|---------|---------|---------|---------|
|               |         |       |      | RATIO 1                 | RATIO 2 | RATIO 3 | RATIO 4 | RATIO 5 | RATIO 6 | RATIO 7 | RATIO 8 | RATIO 9 |
|               |         |       |      | .20                     | .30     | .40     | .50     | .60     | .70     | .80     | .90     | 1.00    |
| HYDROGRAPH AT | INFLOW  | .70   | 1    | 390.                    | 585.    | 780.    | 975.    | 1170.   | 1364.   | 1559.   | 1754.   | 1949.   |
|               |         | 1.51) | (    | 11.04)                  | 16.56)  | 22.08)  | 27.60)  | 33.12)  | 38.64)  | 44.16)  | 49.67)  | 55.19)  |
| ROUTED TO     | OUTFLO  | .70   | 1    | 0.                      | 0.      | 0.      | 0.      | 0.      | 0.      | 0.      | 0.      | 0.      |
|               |         | 1.81) | (    | 0.00)                   | 0.00)   | 0.00)   | 0.00)   | 0.00)   | 0.00)   | 0.00)   | 0.00)   | 0.00)   |

# SUMMARY OF DAM SAFETY ANALYSIS

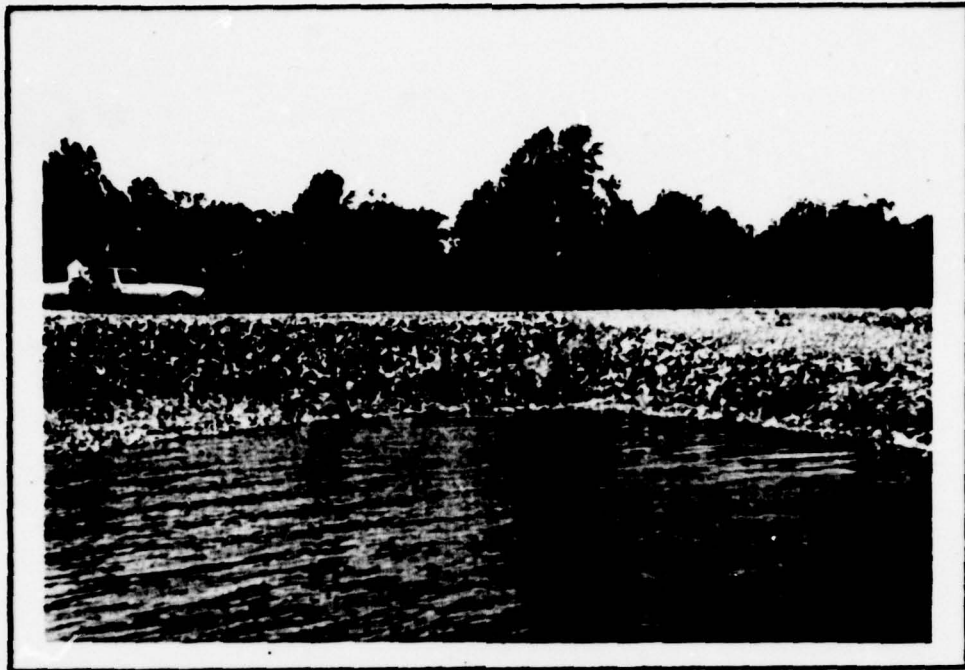
| PLAN 1 .....       |                                  |                              |                             |                           |                               |                                 |                             |
|--------------------|----------------------------------|------------------------------|-----------------------------|---------------------------|-------------------------------|---------------------------------|-----------------------------|
| ELEVATION          |                                  | INITIAL VALUE                |                             | SPILLWAY CREST            |                               | TOP OF DAM                      |                             |
| STORAGE            |                                  | 608.10                       |                             | 615.00                    |                               | 615.00                          |                             |
| OUTFLOW            |                                  | 518.                         |                             | 1637.                     |                               | 1637.                           |                             |
|                    |                                  | 0.                           |                             | 0.                        |                               | 0.                              |                             |
| RATIO<br>OF<br>PWF | MAXIMUM<br>RESERVOIR<br>W.S.ELEV | MAXIMUM<br>DEPTH<br>OVER DAM | MAXIMUM<br>STORAGE<br>AC-FT | MAXIMUM<br>OUTFLOW<br>CFS | DURATION<br>OVER TOP<br>HOURS | TIME OF<br>MAX OUTFLOW<br>HOURS | TIME OF<br>FAILURE<br>HOURS |
| .20                | 509.62                           | 0.00                         | 702.                        | 0.                        | 0.00                          | 0.00                            | 0.00                        |
| .30                | 510.24                           | 0.00                         | 744.                        | 0.                        | 0.00                          | 0.00                            | 0.00                        |
| .40                | 510.83                           | 0.00                         | 786.                        | 0.                        | 0.00                          | 0.00                            | 0.00                        |
| .50                | 511.40                           | 0.00                         | 828.                        | 0.                        | 0.00                          | 0.00                            | 0.00                        |
| .60                | 511.95                           | 0.00                         | 870.                        | 0.                        | 0.00                          | 0.00                            | 0.00                        |
| .70                | 512.48                           | 0.00                         | 913.                        | 0.                        | 0.00                          | 0.00                            | 0.00                        |
| .80                | 513.00                           | 0.00                         | 955.                        | 0.                        | 0.00                          | 0.00                            | 0.00                        |
| .90                | 513.50                           | 0.00                         | 997.                        | 0.                        | 0.00                          | 0.00                            | 0.00                        |
| 1.00               | 513.98                           | 0.00                         | 1435.                       | 0.                        | 0.00                          | 0.00                            | 0.00                        |



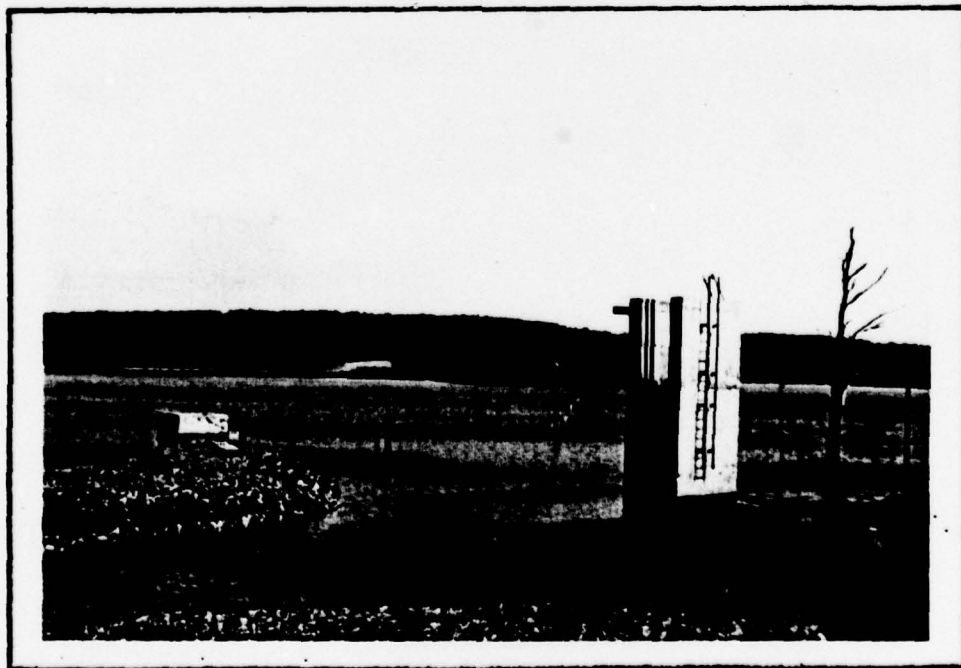
APPENDIX

D

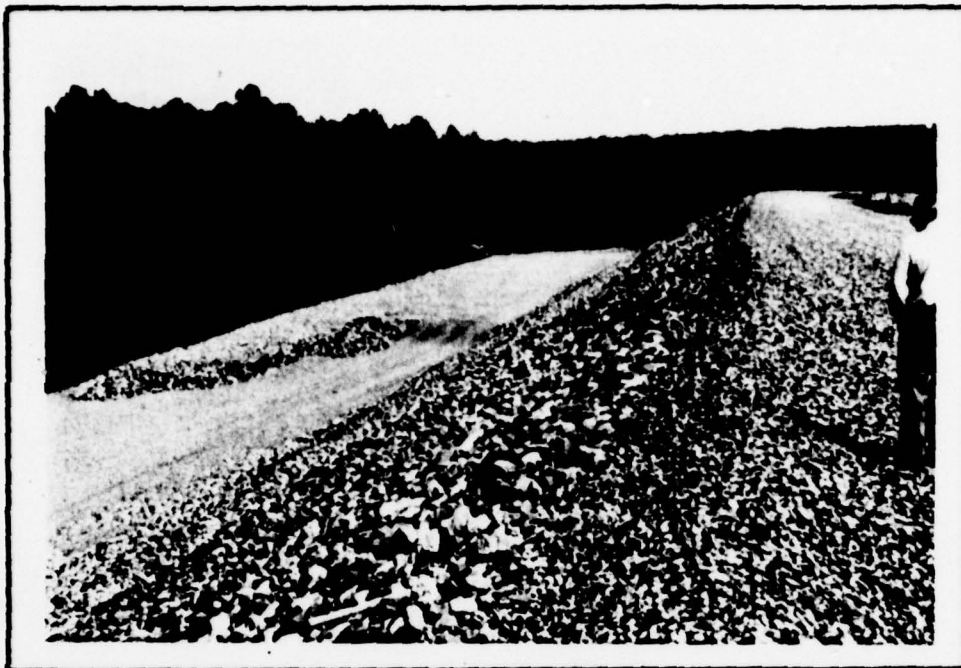
Photographs



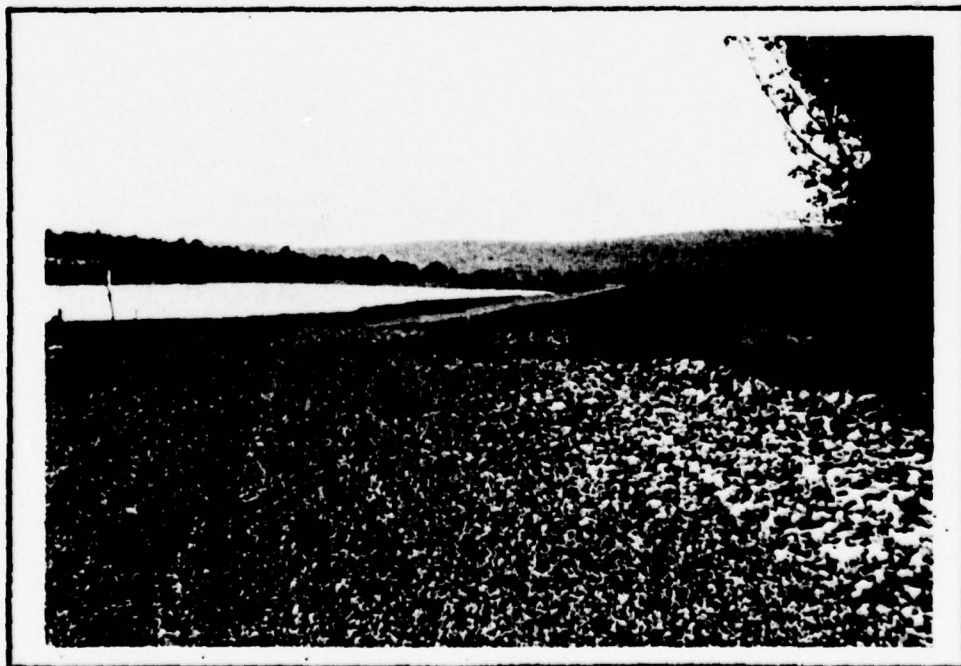
*VIEW OF THE ROCK FILLED SPILLWAY SECTION  
NEAR THE LEFT ABUTMENT*



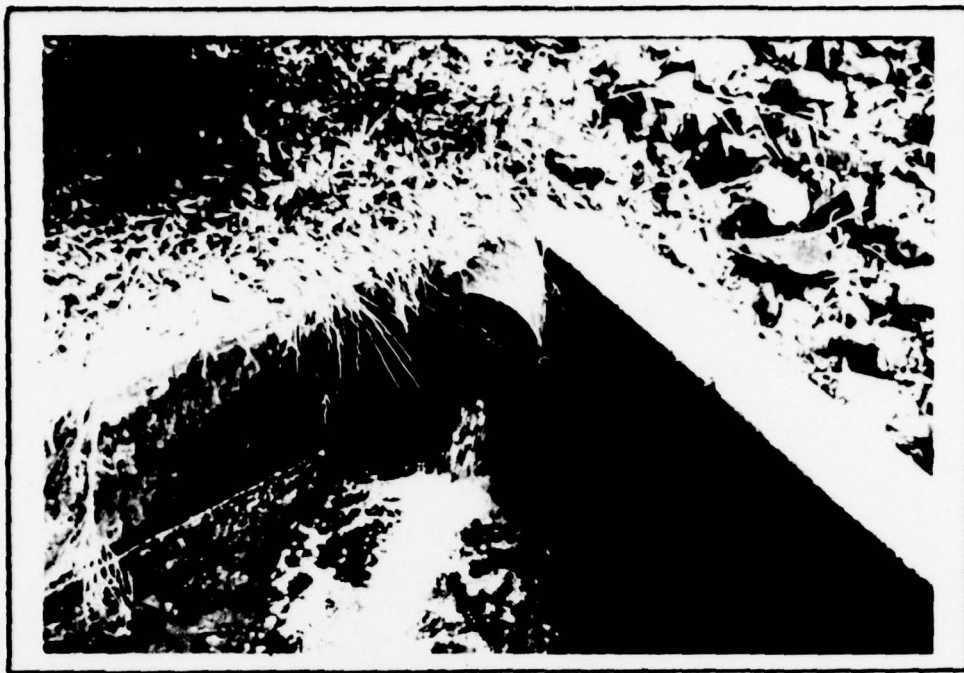
*DECANT #4 (NEARLY SUBMERGED) AND DECANT #5  
NEAR THE LEFT ABUTMENT*



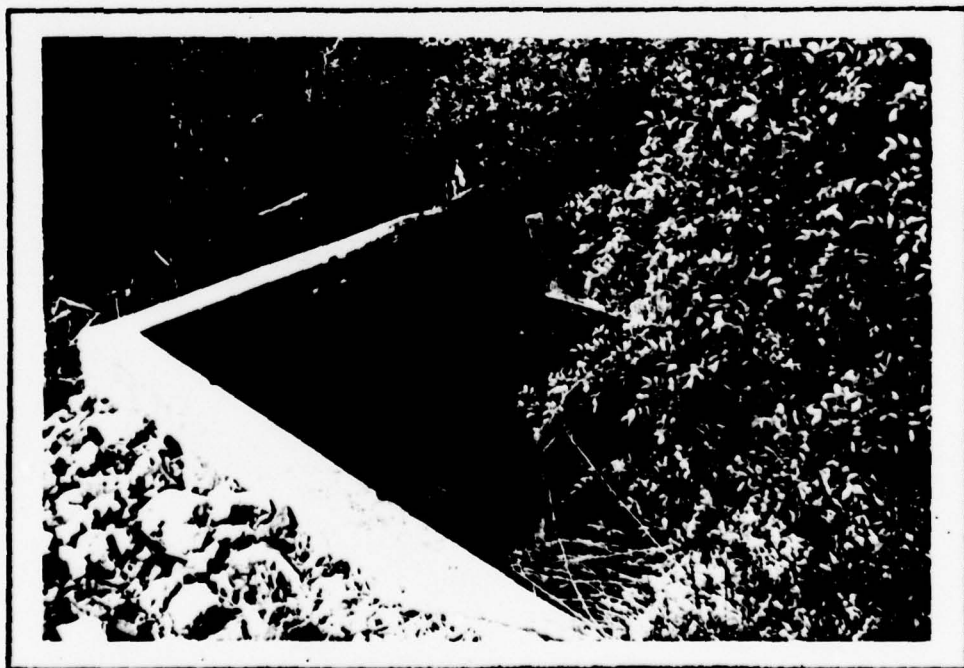
*TOP PORTION OF THE DOWNSTREAM SLOPE  
AND THE DOWNSTREAM BERM*



*VIEW OF THE DAM AND RESERVOIR AS  
SEEN FROM THE RIGHT ABUTMENT*



*20 INCH DIAMETER STEEL OUTLET PIPE AT THE  
DOWNSTREAM TOE OF THE DAM*



*CONCRETE BOX OUTLET STRUCTURE INTO WHICH THE  
20 INCH DIAMETER OUTLET PIPE DISCHARGES*



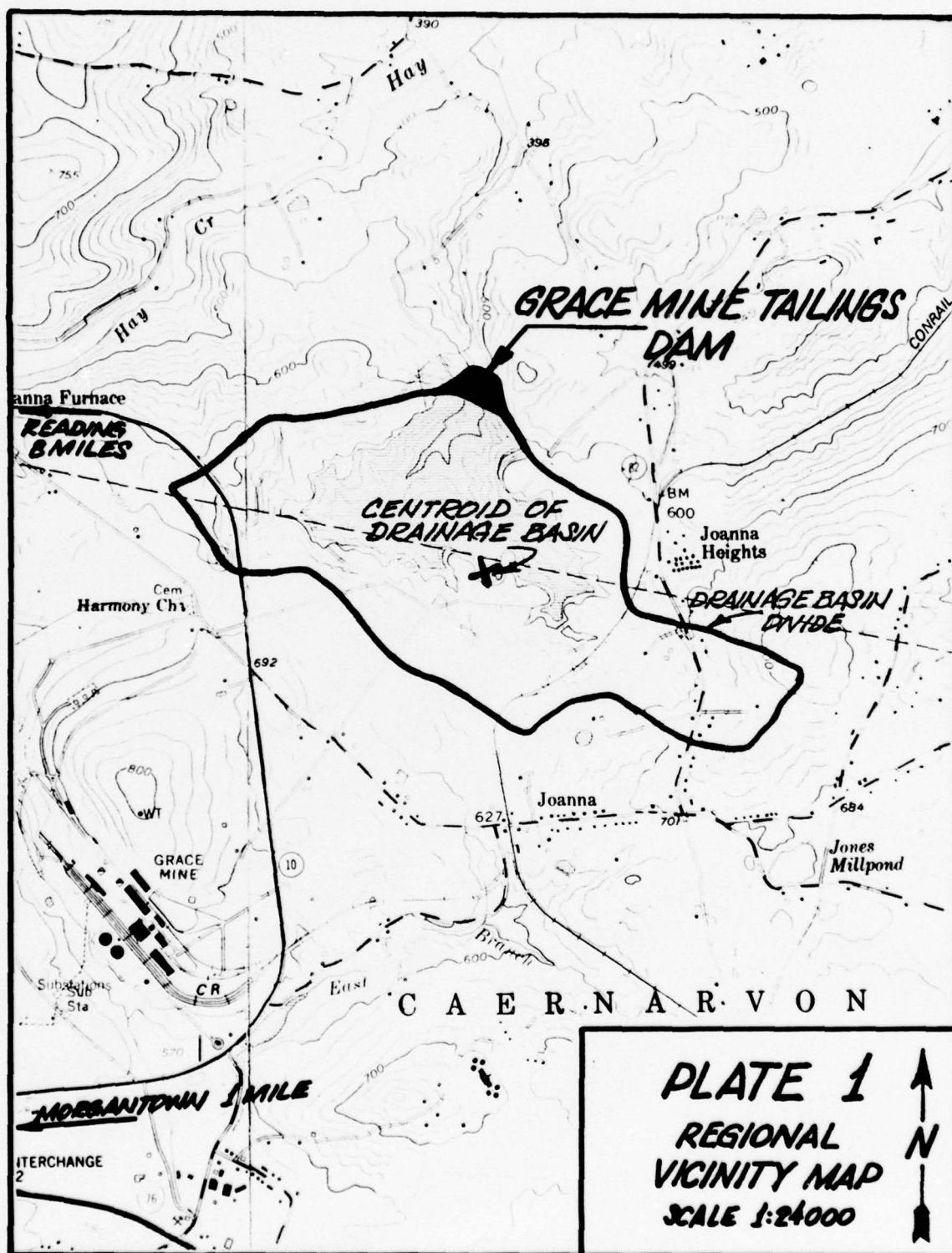
APPENDIX

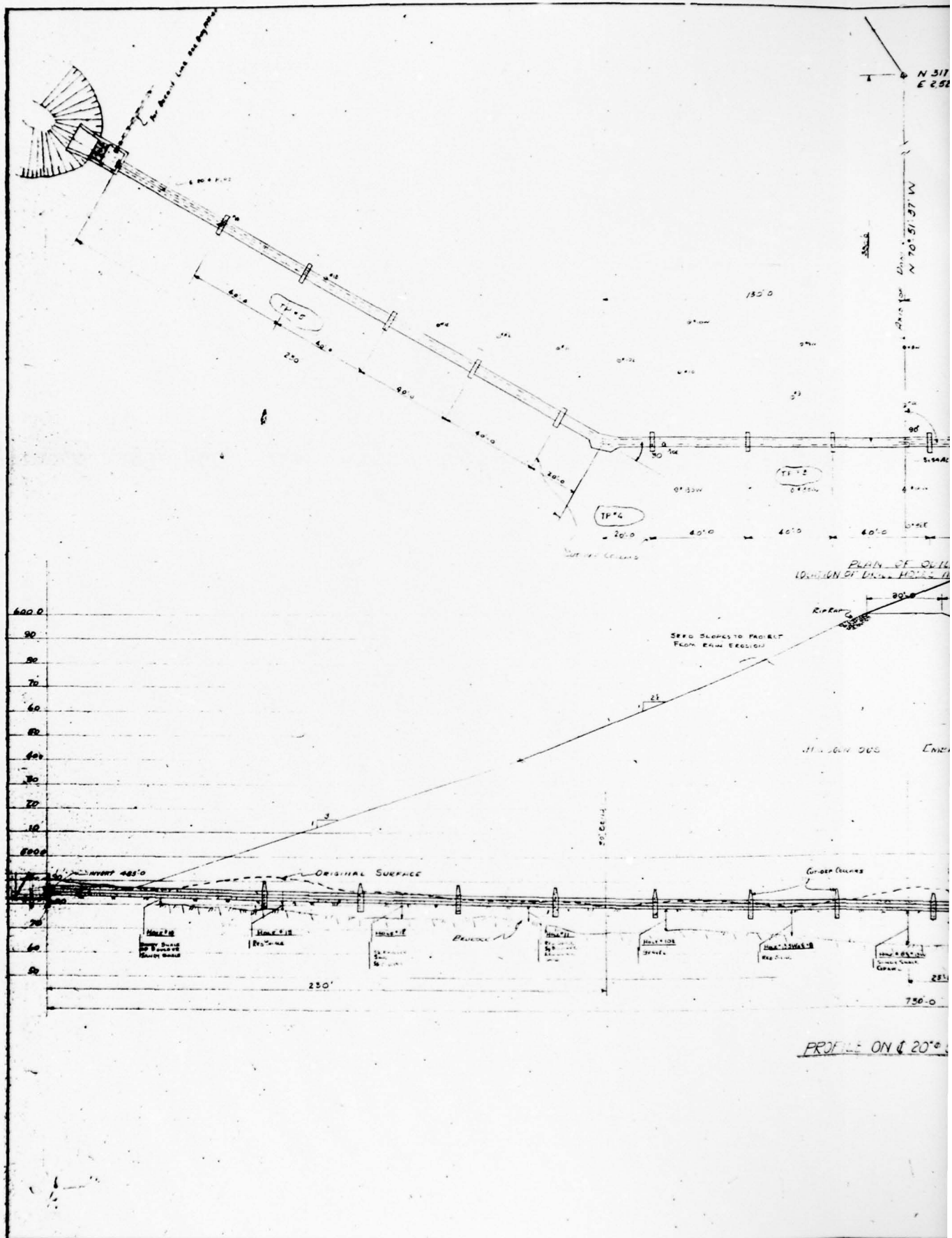
E

Drawings

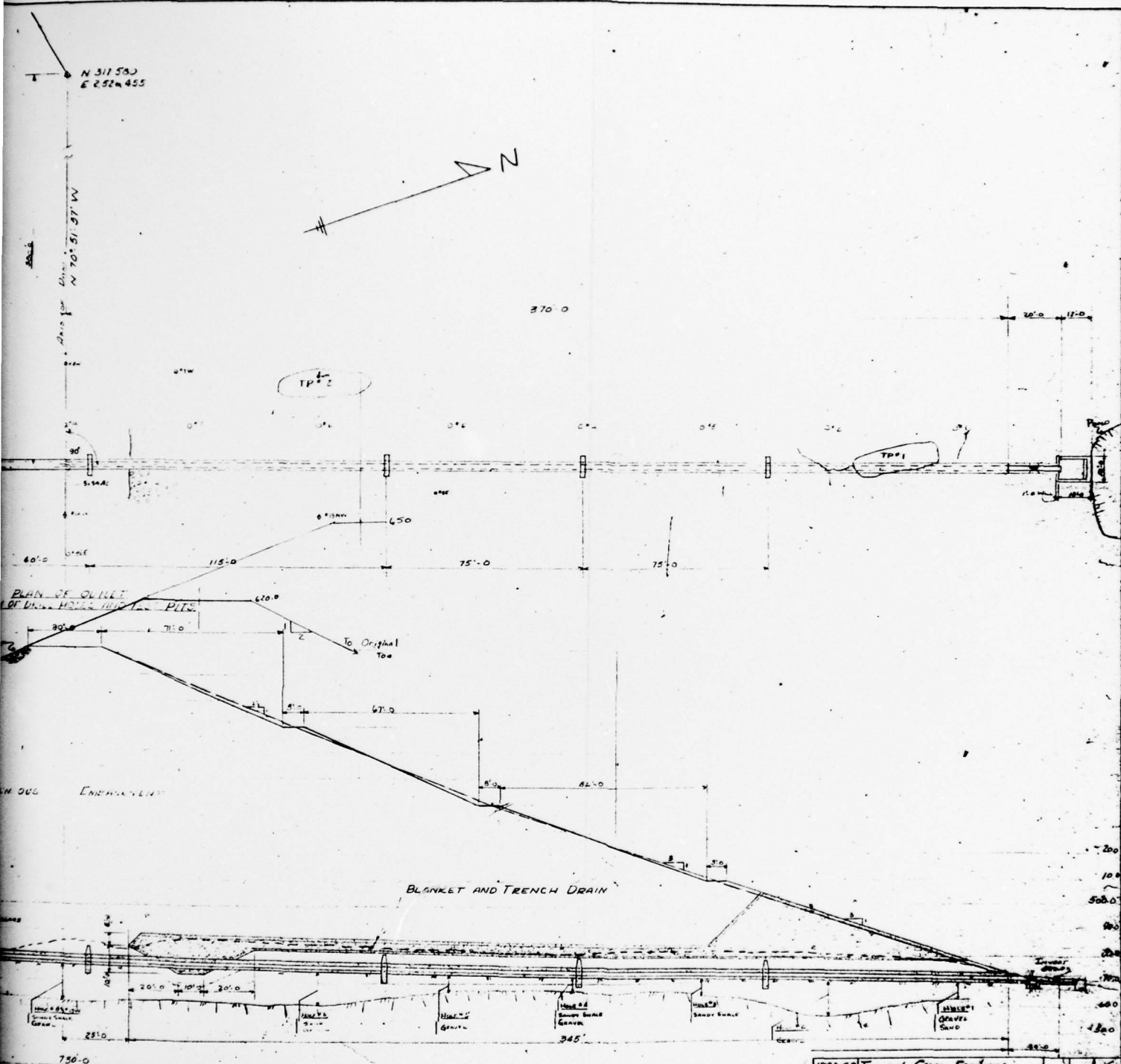
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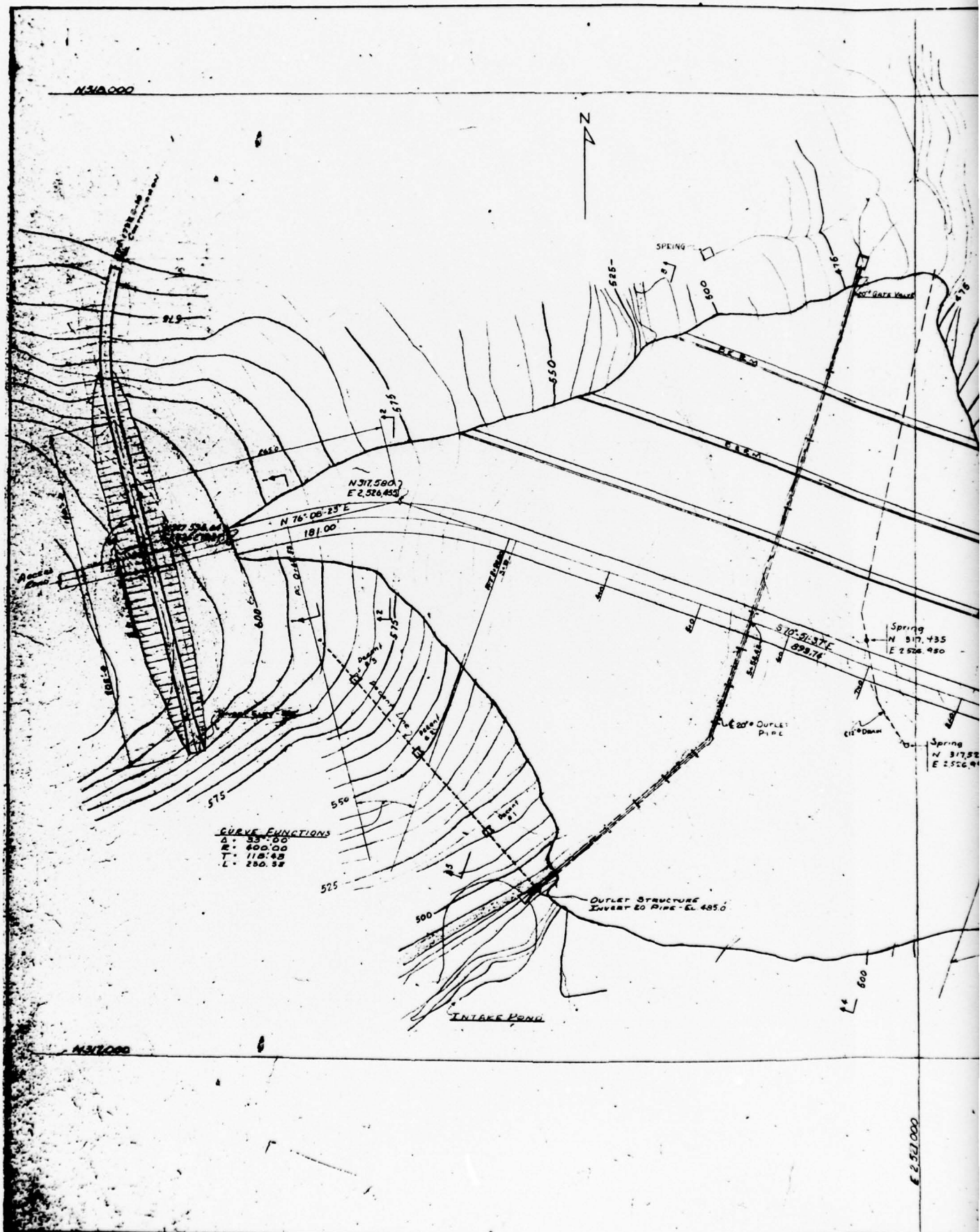


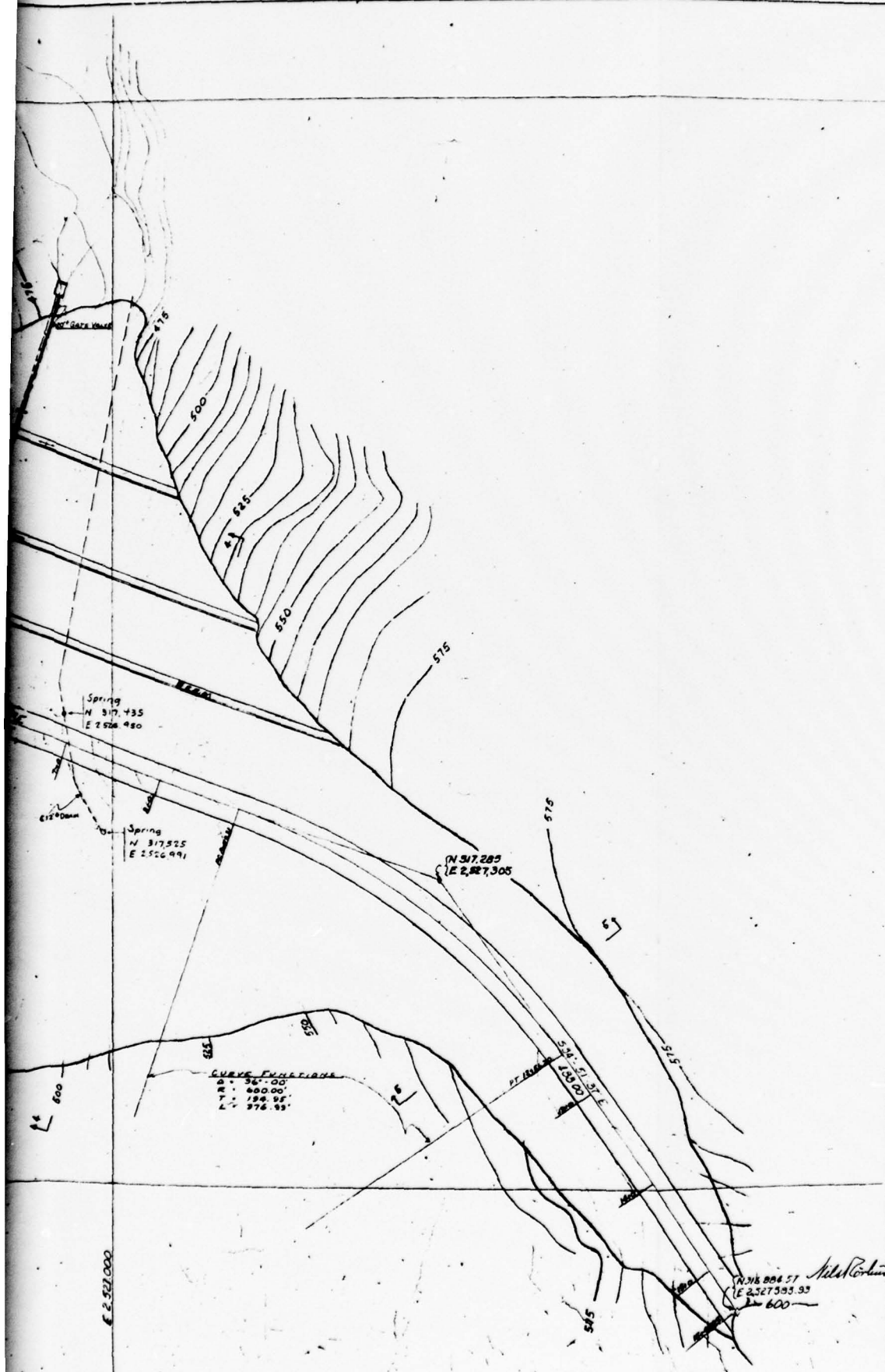
ON 20" OUTLET PIPE.

*W.D. Bowler*

PLATE 2

| 1723-48   | Typical Cross Sections                |                          |  |  |  |
|---|---------------------------------------|--------------------------|--|--|--|
| 1723-47   | Plan of Borrow Areas                  |                          |  |  |  |
| 1723-56   | Plan of Blanket & Trench Drain        |                          |  |  |  |
| 1723-55   | Plan of Dam & Spillway                |                          |  |  |  |
| 1723-53   | Cross-Section & Detail                |                          |  |  |  |
| 1723-41   | Gravel Plant-Tailings Dam & Reservoir |                          |  |  |  |
| No.   | REFERENCES                            | NO. BY DATE<br>REVISIONS |  |  |  |
| <b>PLAN &amp; PROFILE OF 20" OUTLET PIPE</b><br><b>TAILINGS DAM &amp; POND</b><br><b>GRACE MINE-MORGANTOWN DIVISION</b><br><b>BETHLEHEM CUBA IRON MINES COMPANY</b><br>OPERATED BY<br><b>BETHLEHEM CORNWALL CORPORATION</b><br>BETHLEHEM, PA.<br>DRAWN <i>W.D. Bowler</i> CHECKED <i>ATK 1/27/26</i> SCALE 1"=20'<br>TRACED DATE 1/27/26 ORDER<br>APPROVED <i>W.D. Bowler</i> Ltr NO. 1723-50 |                                       |                          |  |  |  |

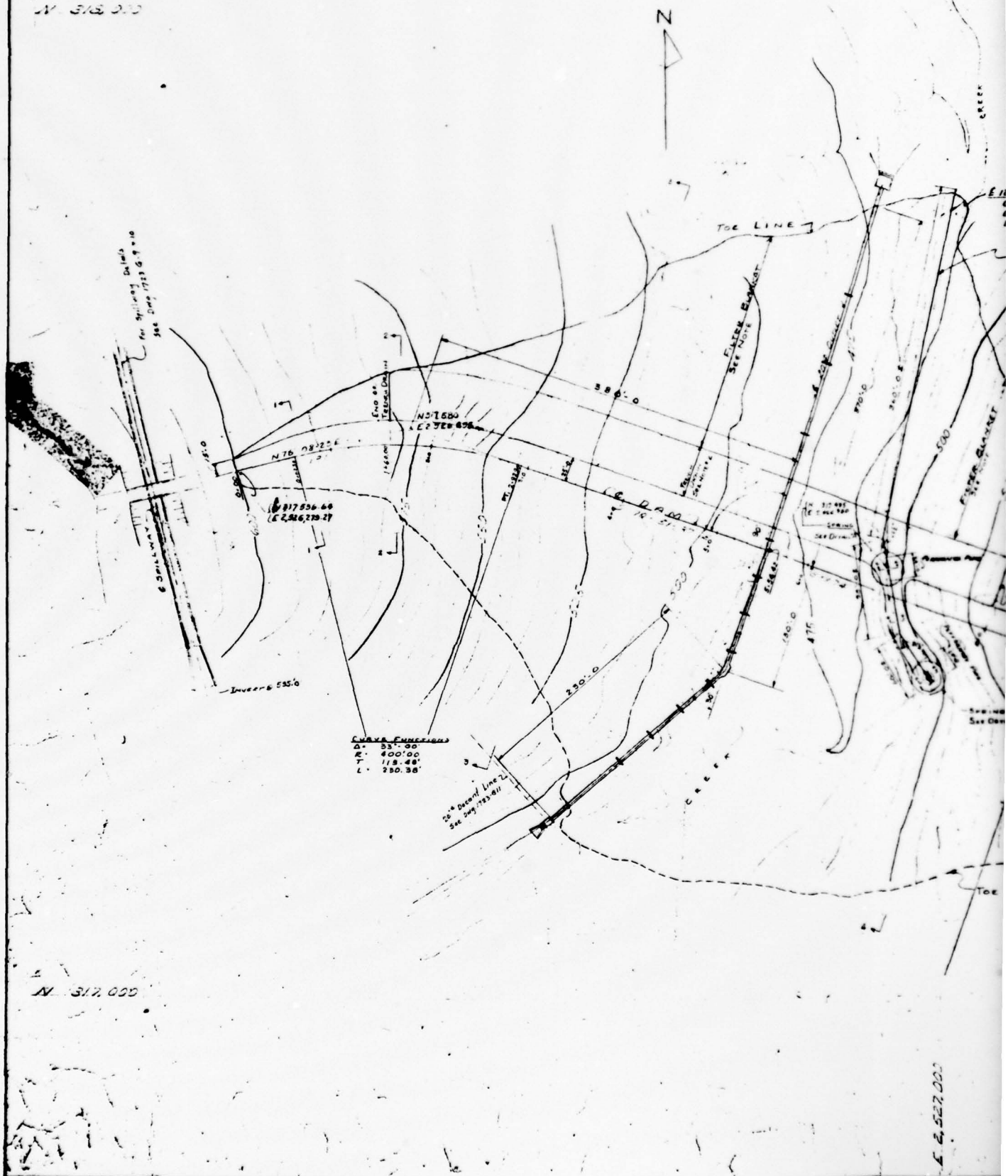




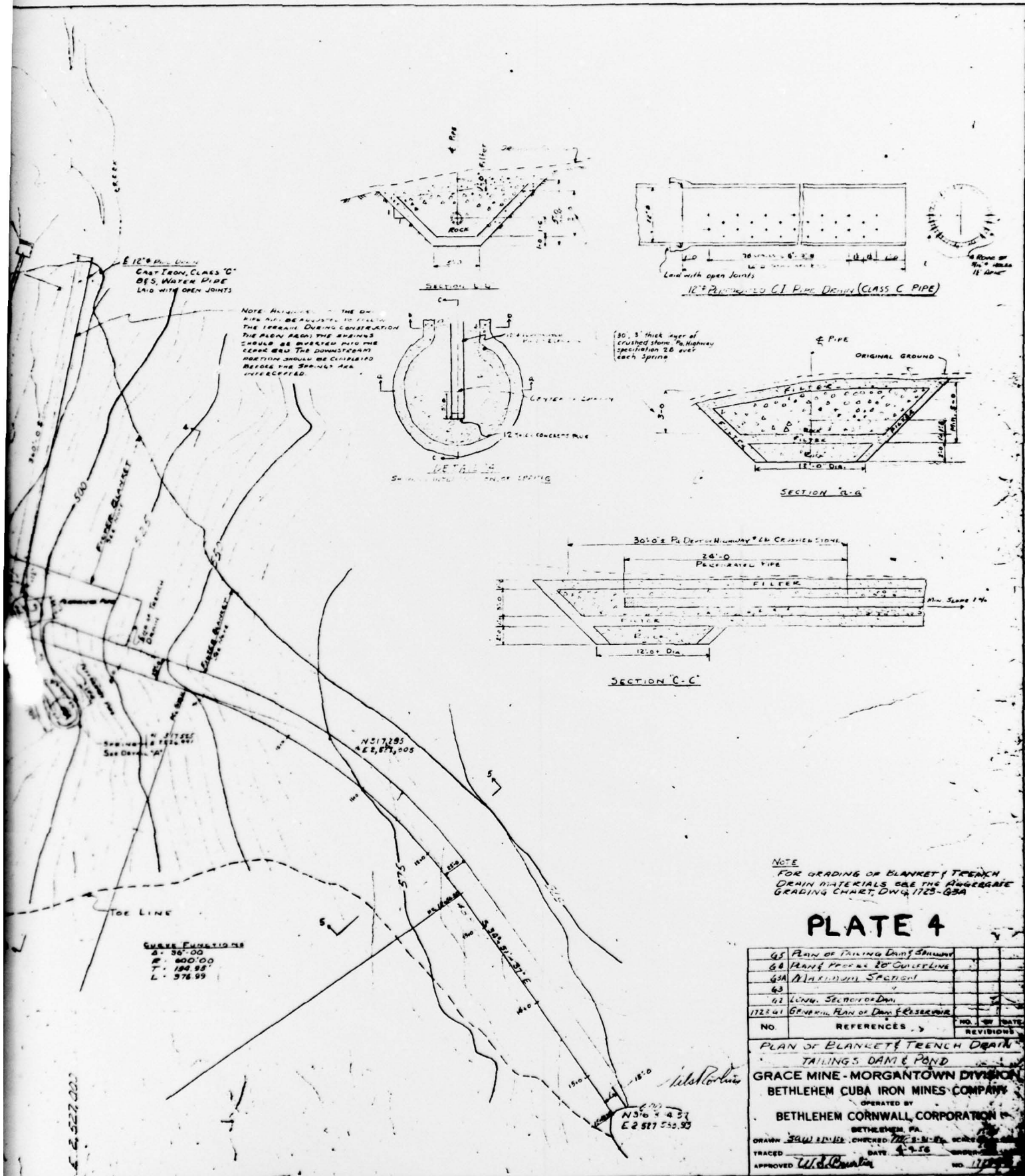
## PLATE 3

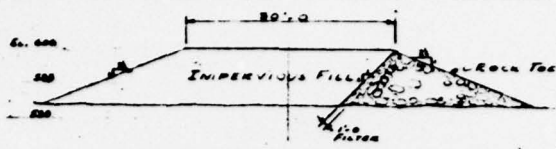
| 1723411                           | FRONT AREA & DETAIL OF DAM        |         |         |
|-----------------------------------|-----------------------------------|---------|---------|
| 1723410                           | SPILLWAY - PLAN & DETAILS         |         |         |
| 1723409                           | SPILLWAY BRIDGE & PROFILE         |         |         |
| 1723408                           | PLAN OF SPILLWAY THROUGH DAM      |         |         |
|                                   | - 64 PLAN PROFILE 20' CORNER PIPE |         |         |
|                                   | - 63 PROFILE SECTION              |         |         |
|                                   | - 62                              |         |         |
|                                   | - 61 TRANSVERSE SECT. THROUGH DAM |         |         |
|                                   | - 60 GENERAL PLAN                 |         |         |
| NO.                               | REFERENCES                        | NO.     | BY      |
|                                   |                                   |         | REVISOR |
| PLAN OF DAM AND SPILLWAY          |                                   |         |         |
| TAILING DAM AND ROAD              |                                   |         |         |
| GRACE MINE - MORGANTOWN DIVISION  |                                   |         |         |
| BETHLEHEM CUBA IRON MINES COMPANY |                                   |         |         |
| OPERATED BY                       |                                   |         |         |
| BETHLEHEM CORNWALL CORPORATION    |                                   |         |         |
| BETHLEHEM, PA.                    |                                   |         |         |
| DRAWN                             | 3/1/16                            | CHECKED | 3/1/16  |
| TRACED                            |                                   | DATE    | 3/1/16  |
| APPROVED                          | W. D. ...                         |         | 3/1/16  |

N 312.000

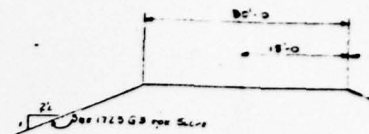




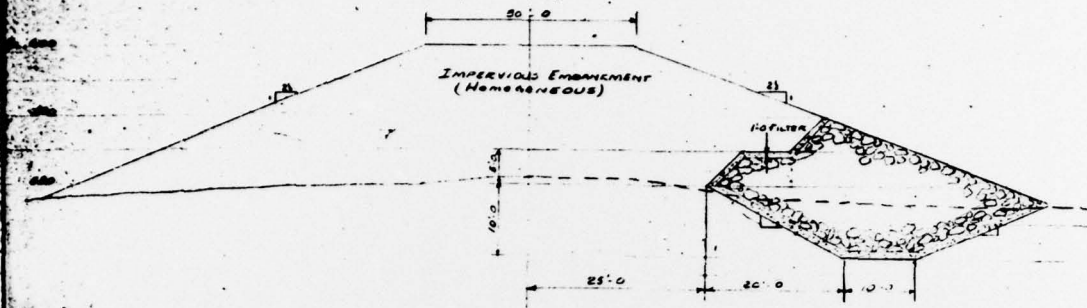




SECTION 1-1



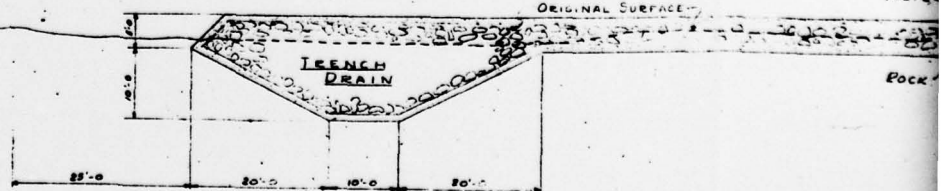
IMPERVIOUS EMBANKMENT  
(HOMOGENEOUS)

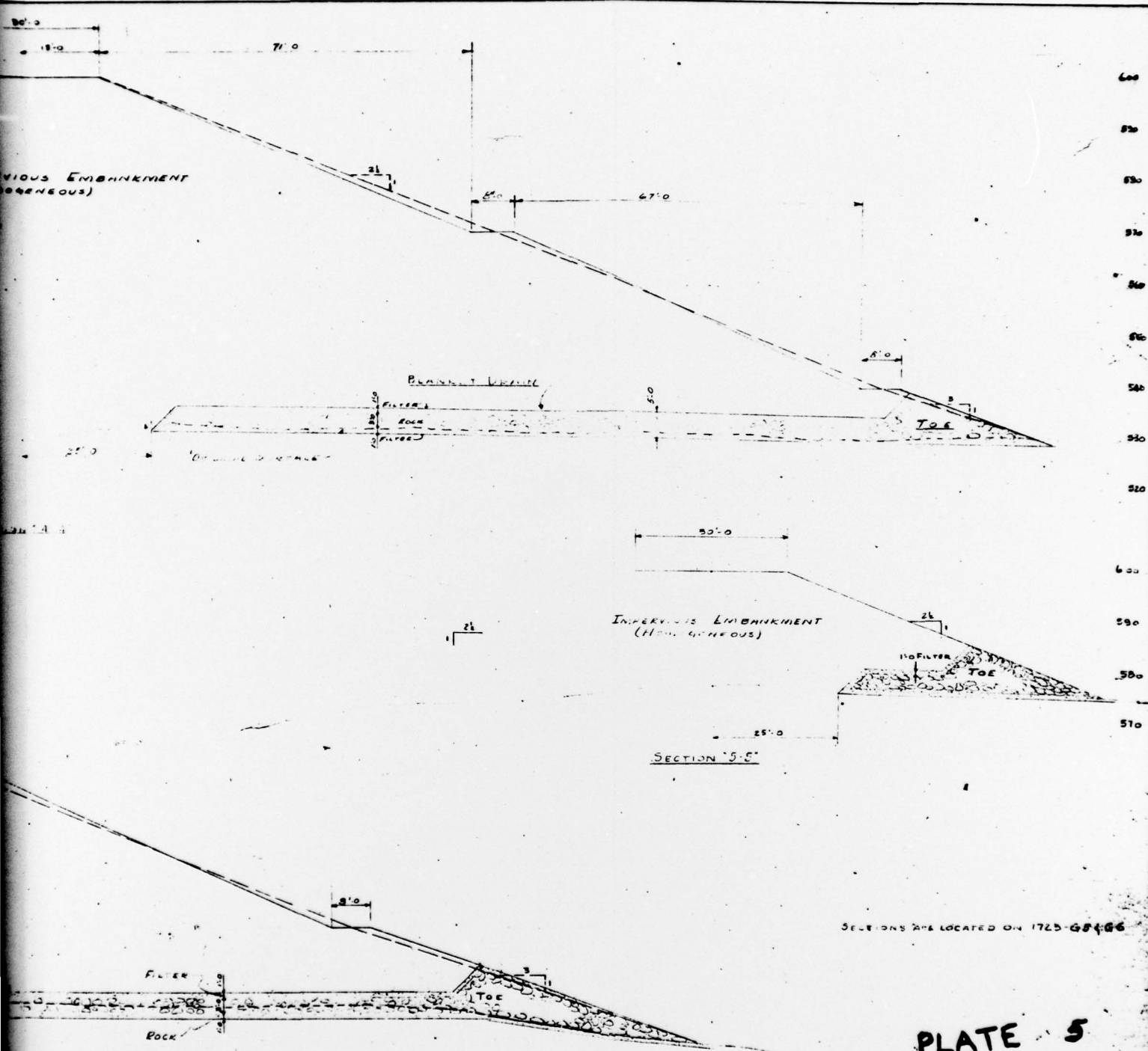


SECTION 2-2



SECTION 3-3





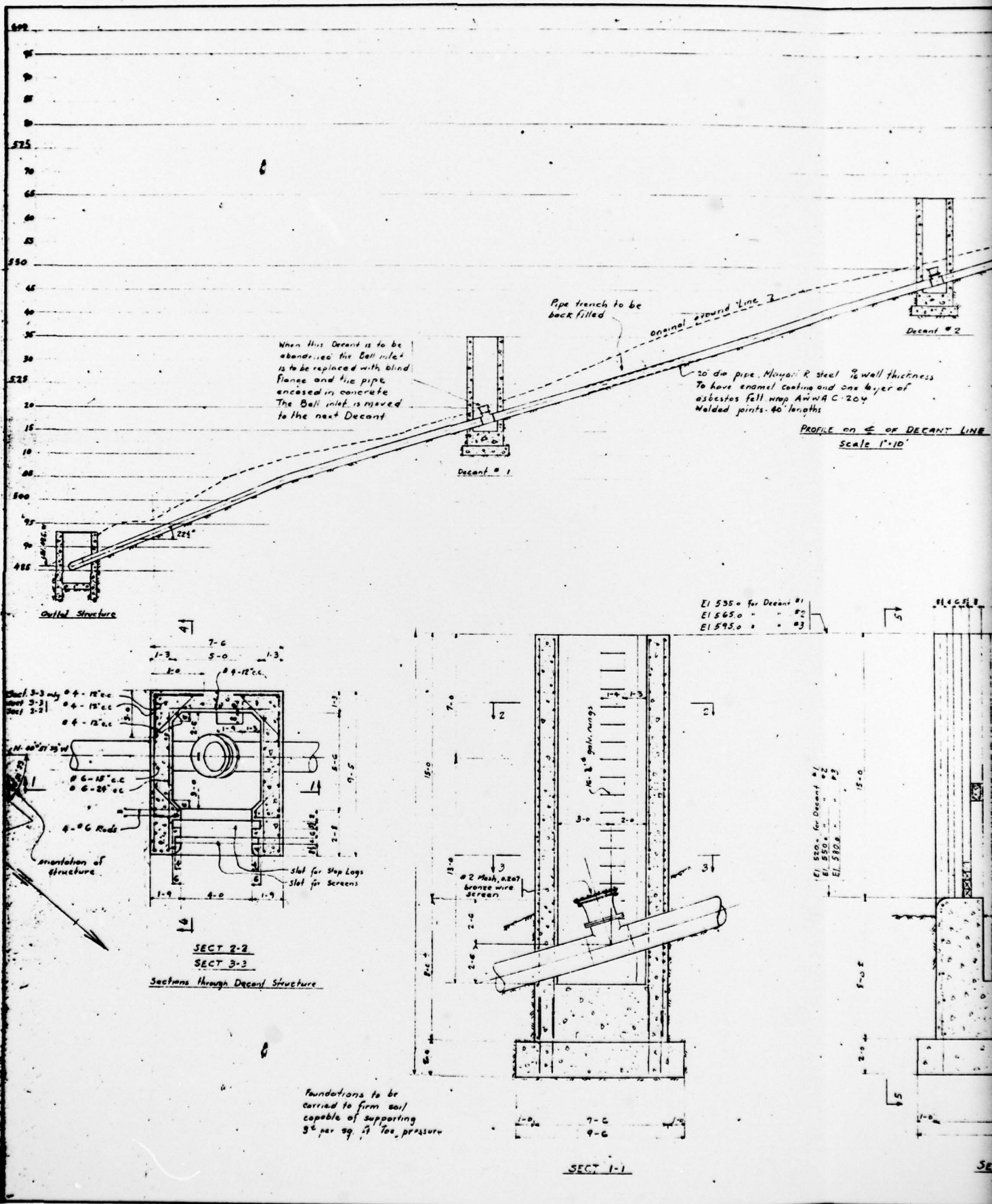
SECTIONS ARE LOCATED ON 1725-68466

# PLATE 5

*W. J. Perkins*

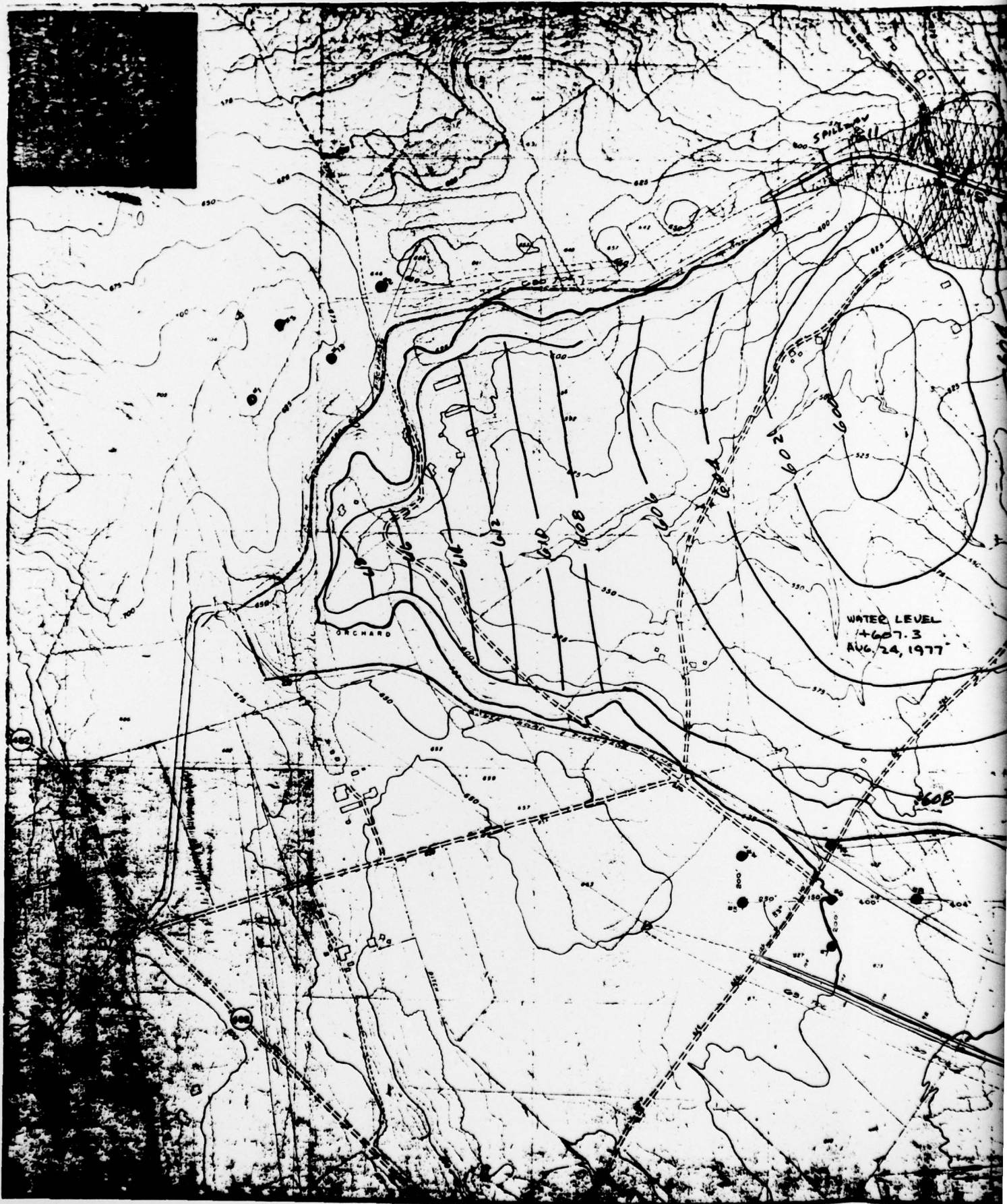
|                                   |                                 |         |               |
|-----------------------------------|---------------------------------|---------|---------------|
| 1725-68466                        | Plan of Embankment              |         |               |
| 68                                | Plan of Tailings Dam & Spillway |         |               |
| 42                                | Dimensional Section             |         |               |
| 624                               | "                               |         |               |
|                                   |                                 |         |               |
|                                   |                                 |         |               |
| NO.                               | REFERENCES                      | REV.    | BY DATE       |
| TYPICAL CROSS-SECTIONS            |                                 |         |               |
| TAILINGS DAM AND POND             |                                 |         |               |
| GRACE MINE - MORGANTOWN DIVISION  |                                 |         |               |
| BETHLEHEM CUBA IRON MINES COMPANY |                                 |         |               |
| OPERATED BY                       |                                 |         |               |
| BETHLEHEM CORNWALL CORPORATION    |                                 |         |               |
| BETHLEHEM, PA.                    |                                 |         |               |
| DRAWN                             | SAW 5125                        | CHECKED | W. J. Perkins |
| DATE                              | 9-9-28                          | DATE    | 9-9-28        |
| APPROVED                          | W. J. Perkins                   | NO.     | 1725-68466    |



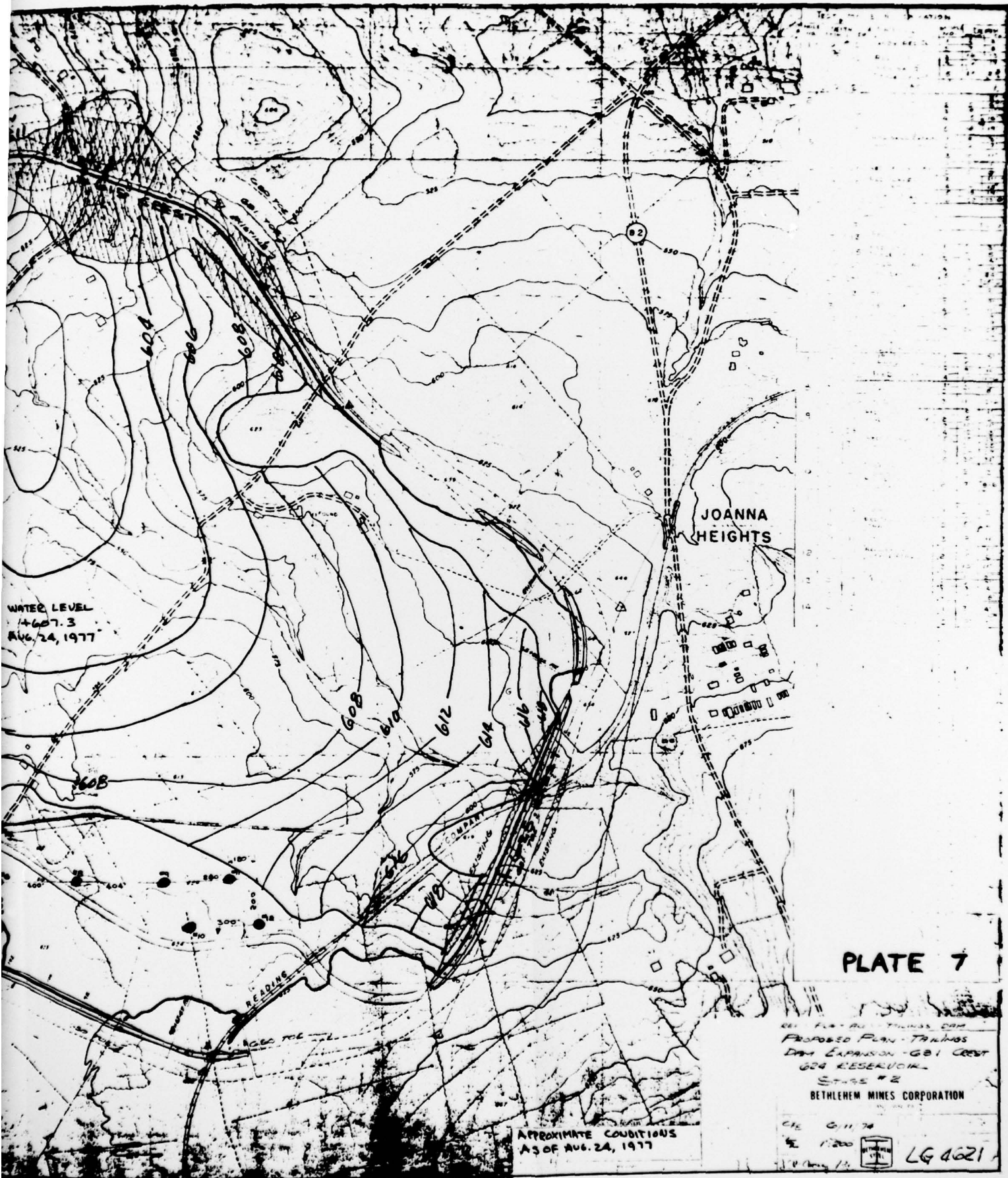


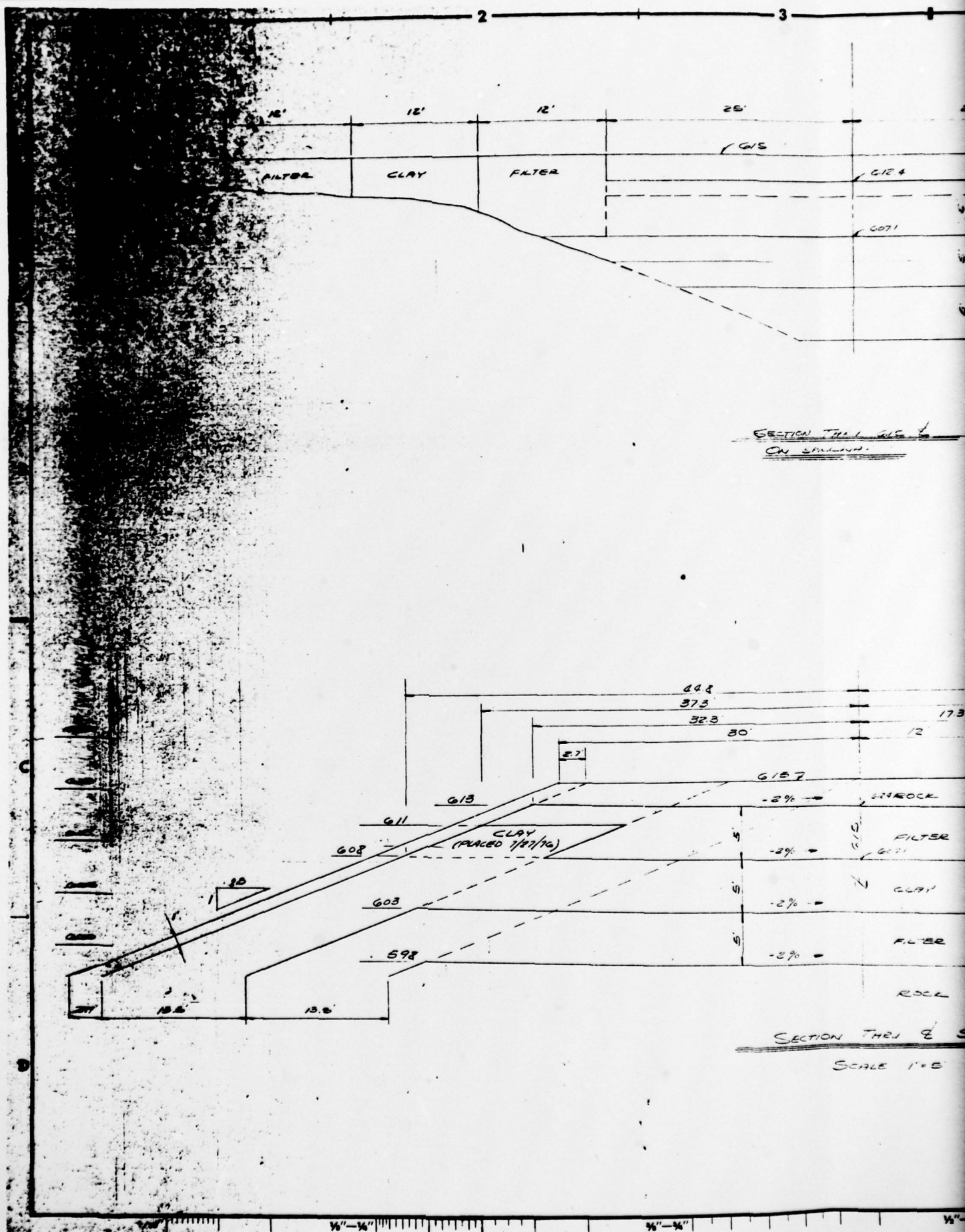




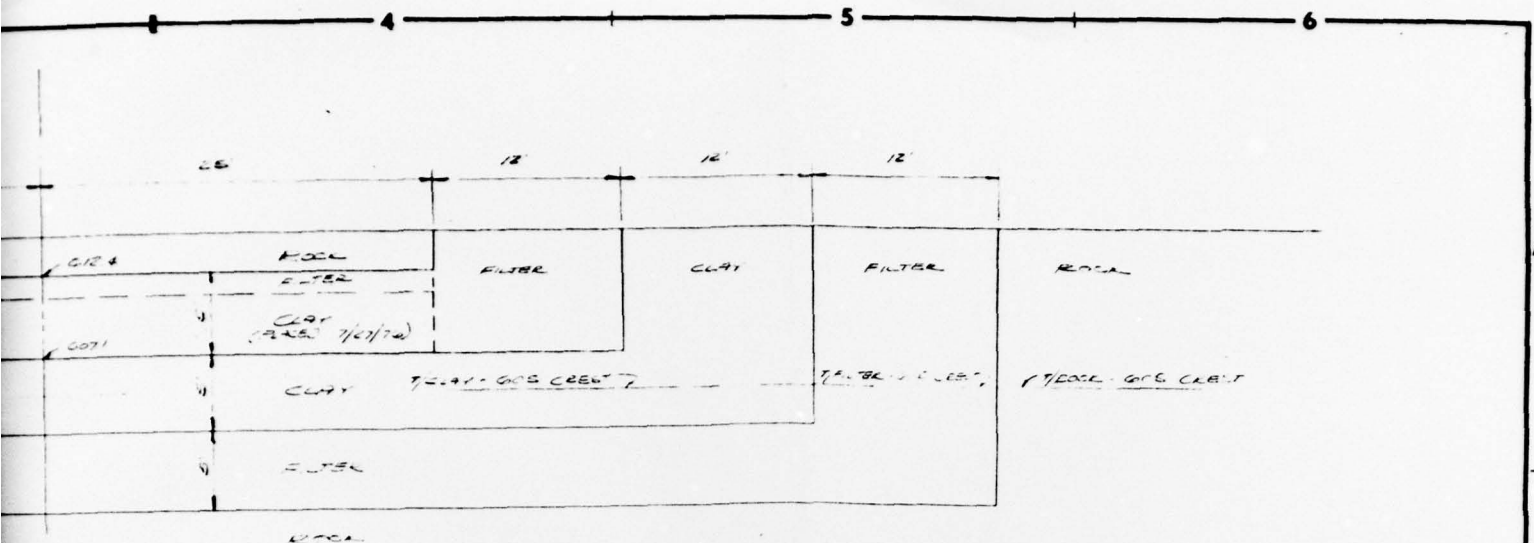




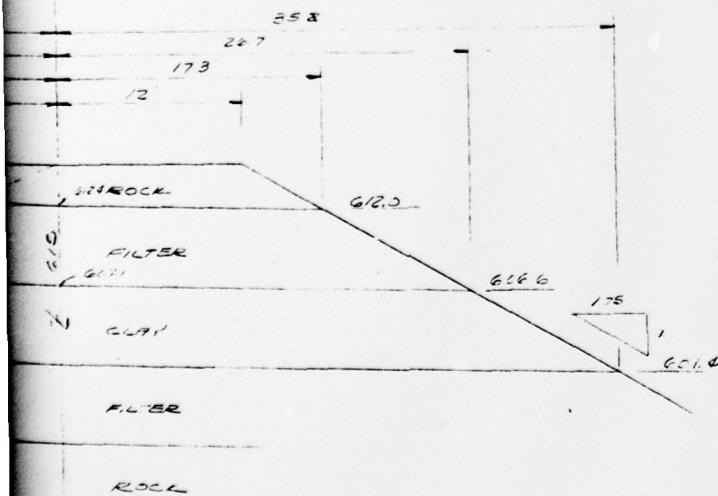








THRU & SPILLWAY



# PLATE 8

THRU & SPILLWAY  
SCALE 1"=5'

|             |         |
|-------------|---------|
| DESIGNED BY | DATE    |
| LG 8107     | 7/21/70 |
| LG 8108     | 7/21/70 |
| APPROVED BY | DATE    |
|             | 7/21/70 |

| REVISION |          | DATE | BY |
|----------|----------|------|----|
| 1        | REVISION |      |    |
| 2        | REVISION |      |    |
| 3        | REVISION |      |    |
| 4        | REVISION |      |    |
| 5        | REVISION |      |    |
| 6        | REVISION |      |    |
| 7        | REVISION |      |    |
| 8        | REVISION |      |    |
| 9        | REVISION |      |    |
| 10       | REVISION |      |    |

IDENTIFIED SECTIONS  
 THRU & SPILLWAY  
 SPILLWAY - GAS CREST  
 2.5' - 7/21/70  
 DETLEHNS MINES CORPORATION  
 MORGANTOWN, PA.  
 LG 5081

SUBJECT

GRACE MINE TAILINGS DAM

SHEET

BY

RRE

DATE

JOB NO

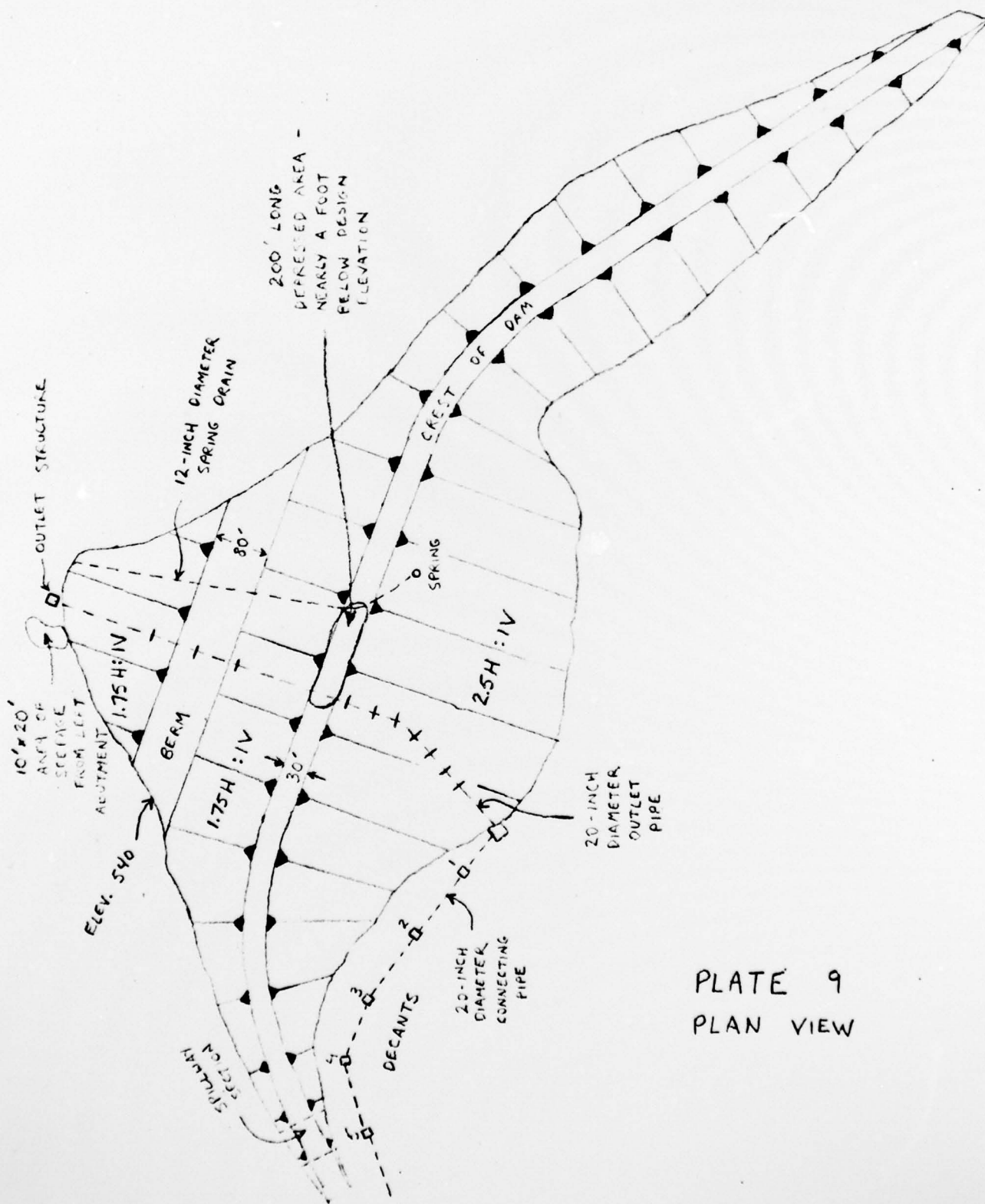
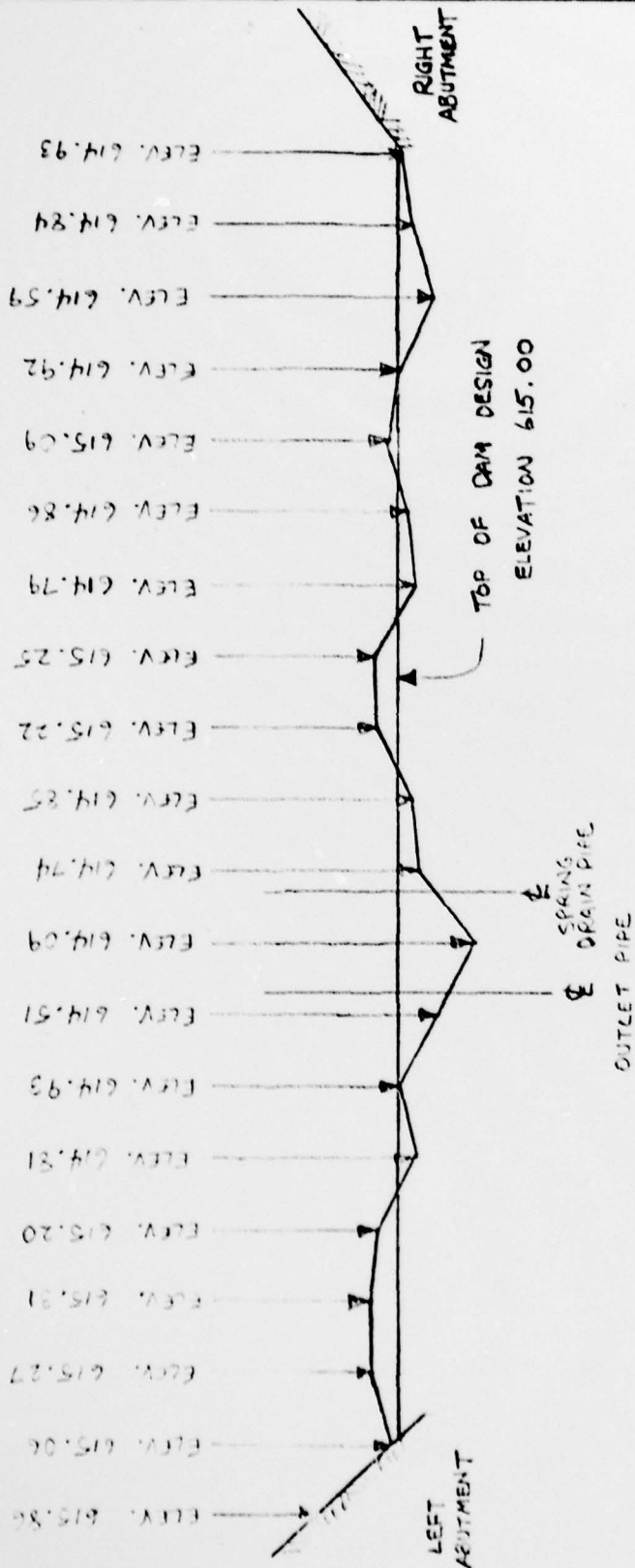


PLATE 9  
PLAN VIEW

|                         |       |     |      |         |
|-------------------------|-------|-----|------|---------|
| SUBJECT                 | SHEET | BY  | DATE | JOB NO. |
| GRACE MINE TAILINGS DAM |       | RRB |      |         |



HOR. SCALE: 1" = 240'  
VERT. SCALE: 1" = 2'

PLATE 10  
TOP OF DAM PROFILE  
LOOKING DOWNSTREAM

REFERENCE ELEVATION 610.00  
DECANT # 5 CREST

WATER LEVEL - ELEVATION 608.26

APPENDIX

F

Site Geology



## SITE GEOLOGY

### GRACE MINE TAILINGS DAM

Grace Mine is located in the Triassic Lowlands section of the Piedmont physiographic province. Bedrock consists of quartzose conglomerates and red sandstones of the Brunswick formation. These sedimentary beds dip about  $7^{\circ}$  to  $18^{\circ}$  NE and have a direction of strike at about N  $45^{\circ}$  W. According to the geologic sections developed from subsurface explorations at the dam site, there is a fracture and accompanying shear zone cutting diagonally across the longitudinal areas of the dam. The fractures line trends about NE-SW and intersects the dam centerline about 200 feet west of the stream bed and does not appear to have affected dam stability.

